



Status and performance characterization of the Gemini MCAO System GeMS

SPIE - Amsterdam - July 1st-6th

Presented by B. Neichel



Rigaut et al. - 8447-18 - yesterday

Status and performance characterization of the Gemini MCAO System GeMS

SPIE - Amsterdam - July 1st-6th

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Status and Science readiness of the Gemini MCAO System GeMS

SPIE - Amsterdam - July 1st-6th

Presented by B. Neichel

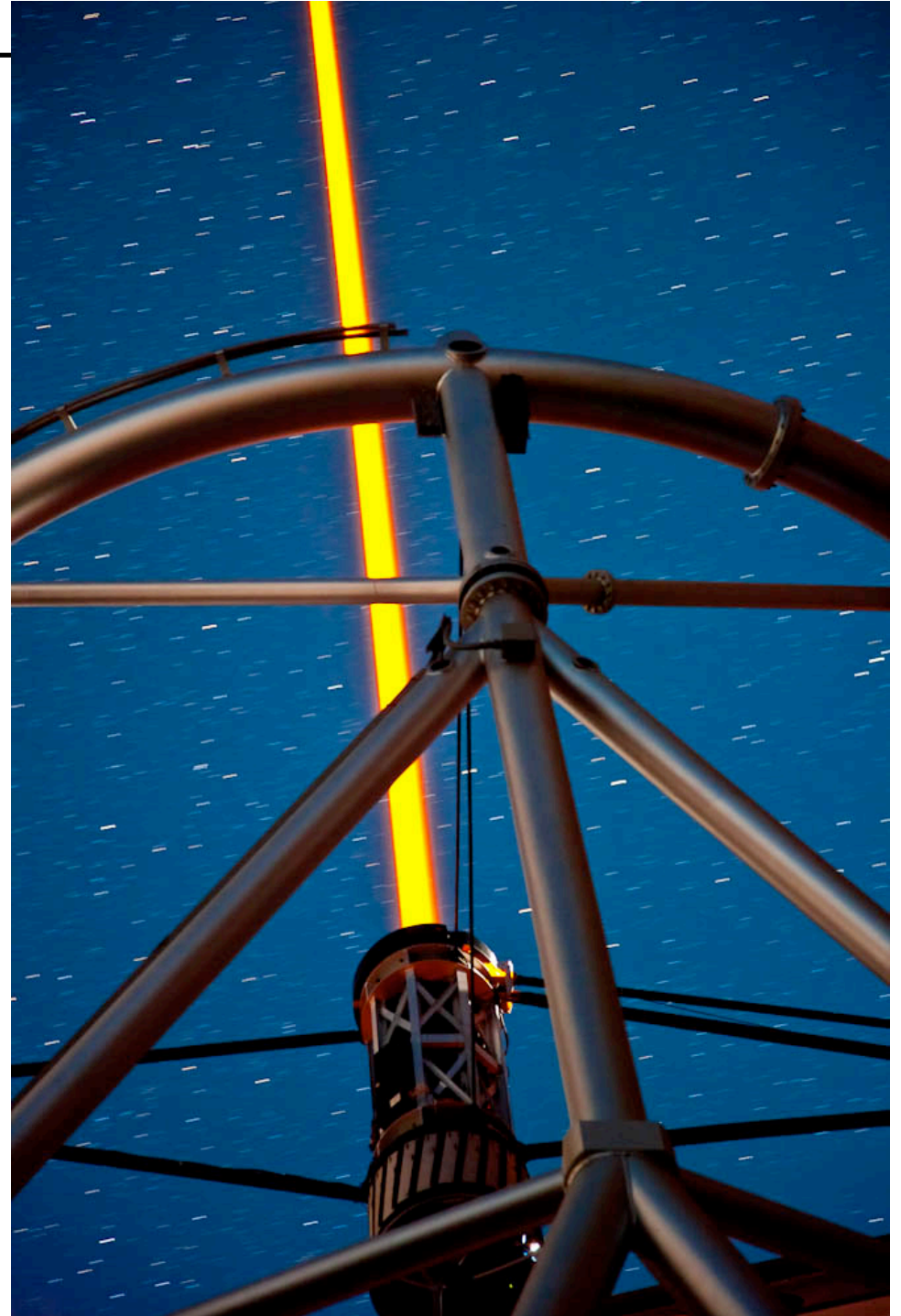
Outline

Introduction to GeMS

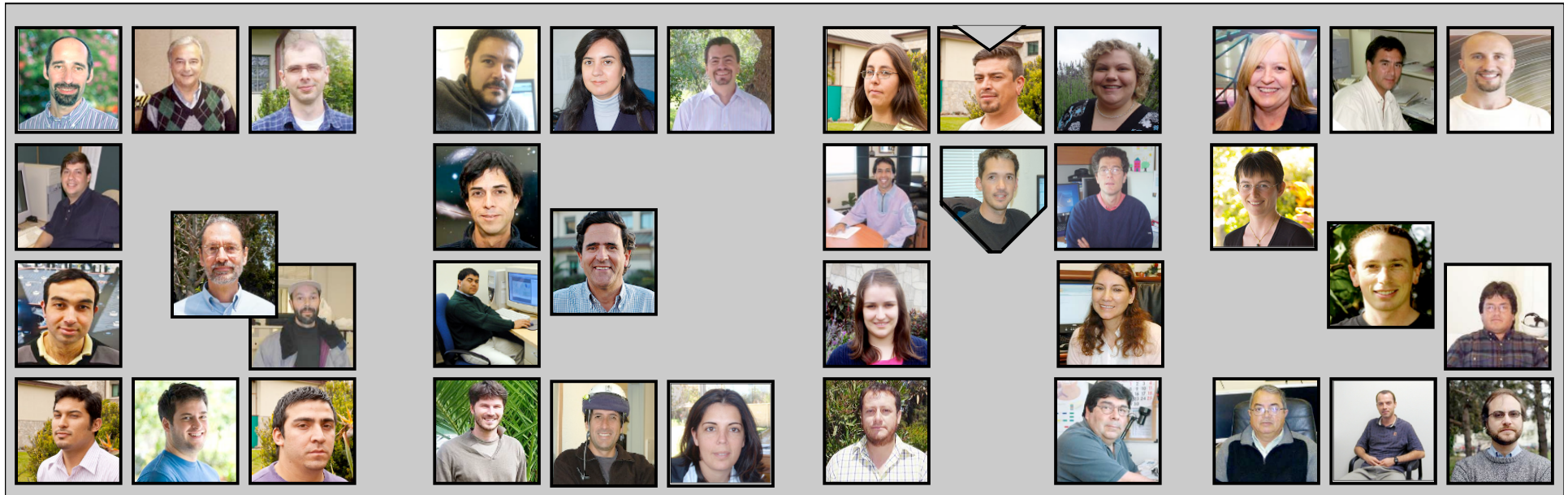
One and half year of
commissioning in a nutshell

From commissioning to
operations

Conclusions



The GeMS team

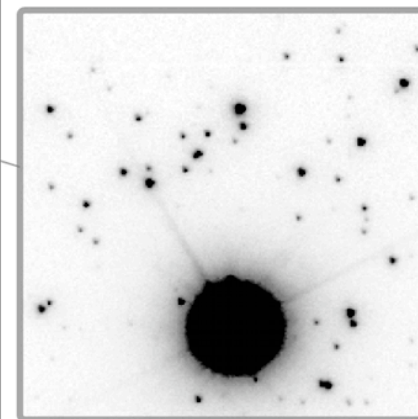
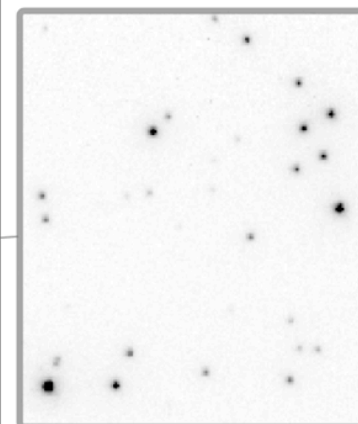
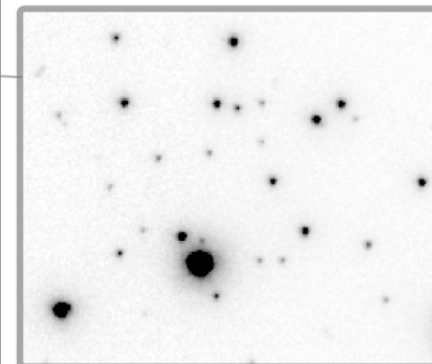
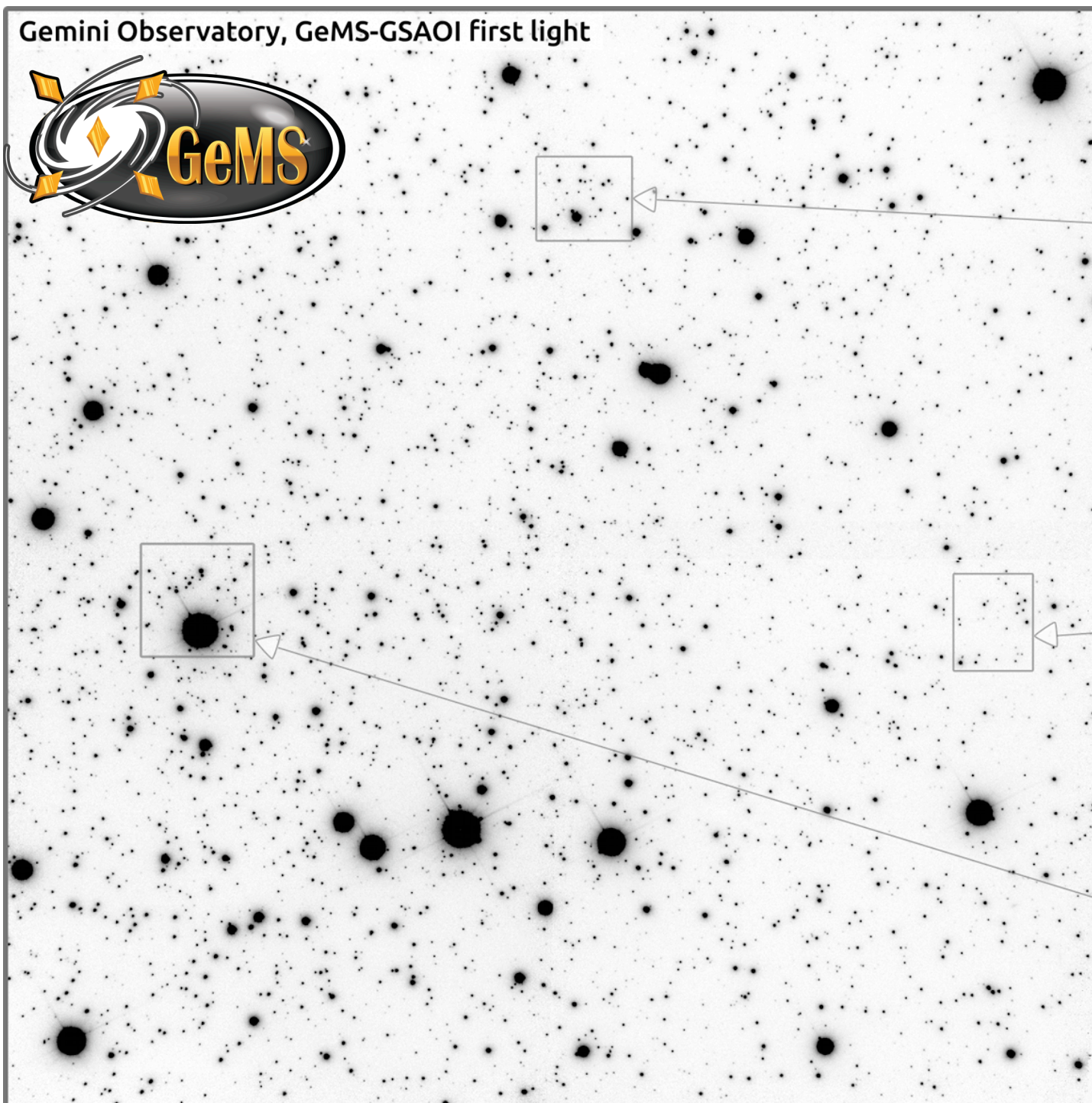


François Rigaut^{a,c}, Benoit Neichel^a, Maxime Boccas^a, Céline d'Orgeville^{a,c}, Gustavo Arriagada^a, Vincent Fesquet^a, Sarah J.Diggs^a, Claudio Marchand^a, Gaston Gausachs^a, William N.Rambold^a, Javier Lurhs^a, Shane Walker^a, Eleazar Rodrigo Carrasco-Damele^a, Michelle L.Edwards^a, Peter Peshev^a, Ramon L.Galvez^a, Tomislav B.Vucina^a, Claudio Arraya^a, Alejandro Gutierrez^a, Angelic W.Ebbers^a, Andrew Serio^a, Cristian Moreno^a, Cristian Urrutia^a, Rolando Rogers^a, Roberto Rojas^a, Chadwick Trujillo^a, Brian Miller^a, Douglas A.Simons^a, Ariel Lopez^a, Vanesa Montes^a, Herman Diaz^a, Felipe Daruich^a, Felipe Colazo^a, Matthieu Bec^b, Gelys Trancho^b, Michael Sheehan^b, Peter McGregor^c, Peter J.Young^c, Matthew C.Doolan^c, Jan van Harmelen^c, Brent L.Ellerbroek^d, Damien Gratadour^e, Aurea Garcia-Rissmann^f

Gemini Observatory, GeMS-GSAOI first light



NGC288, H band
13mn exposure
Field of View 87"x87"
FWHM = 0.080"
FWHM rms = 0.002"





= Gemini (South) MCAO system

GeMS delivers (almost) diffraction
limited images in the NIR

Over a large FoV

With an extremely good uniformity

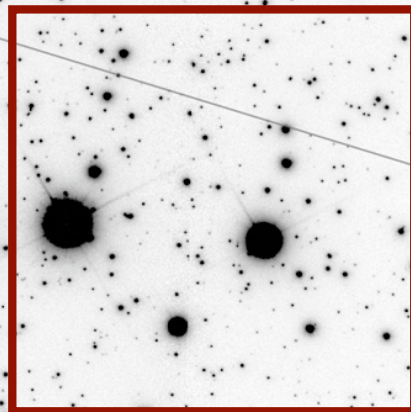
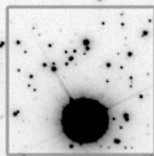
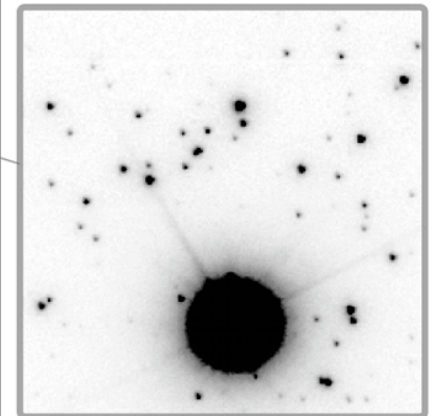
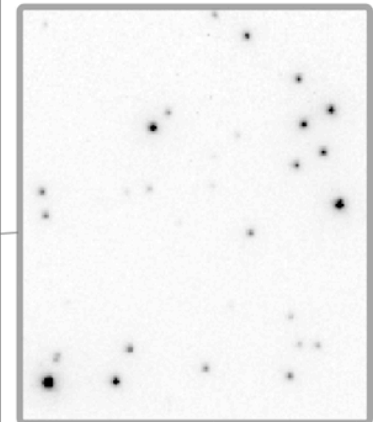
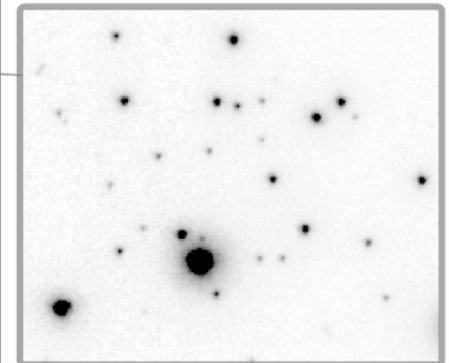
NGC288, H band

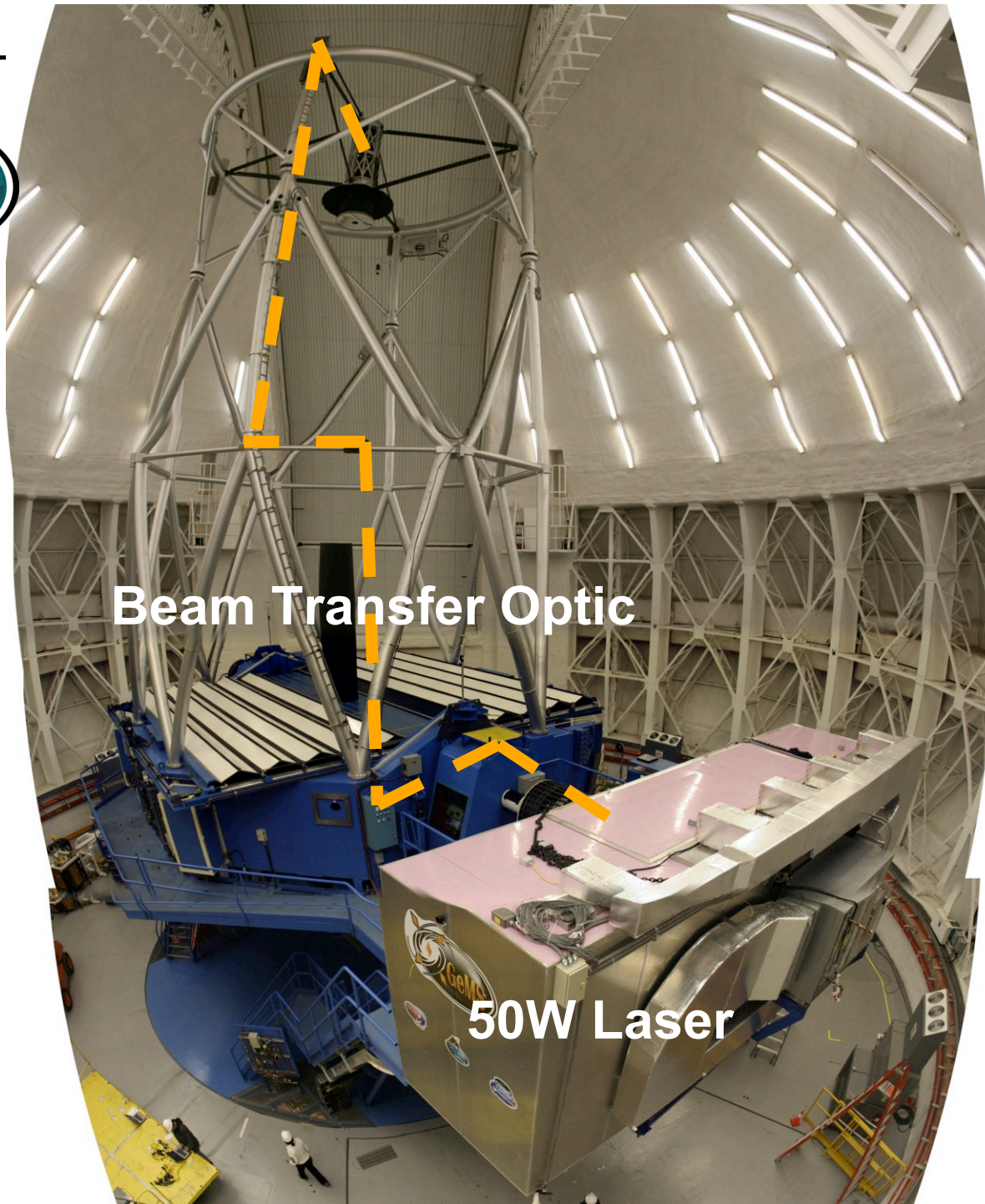
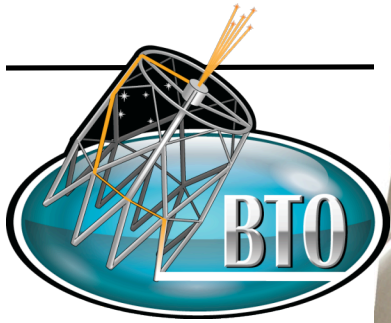
13mn exposure

Field of View 87"x87"

FWHM = 0.080"

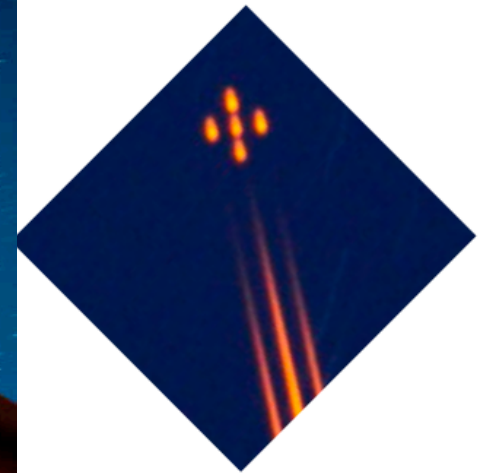
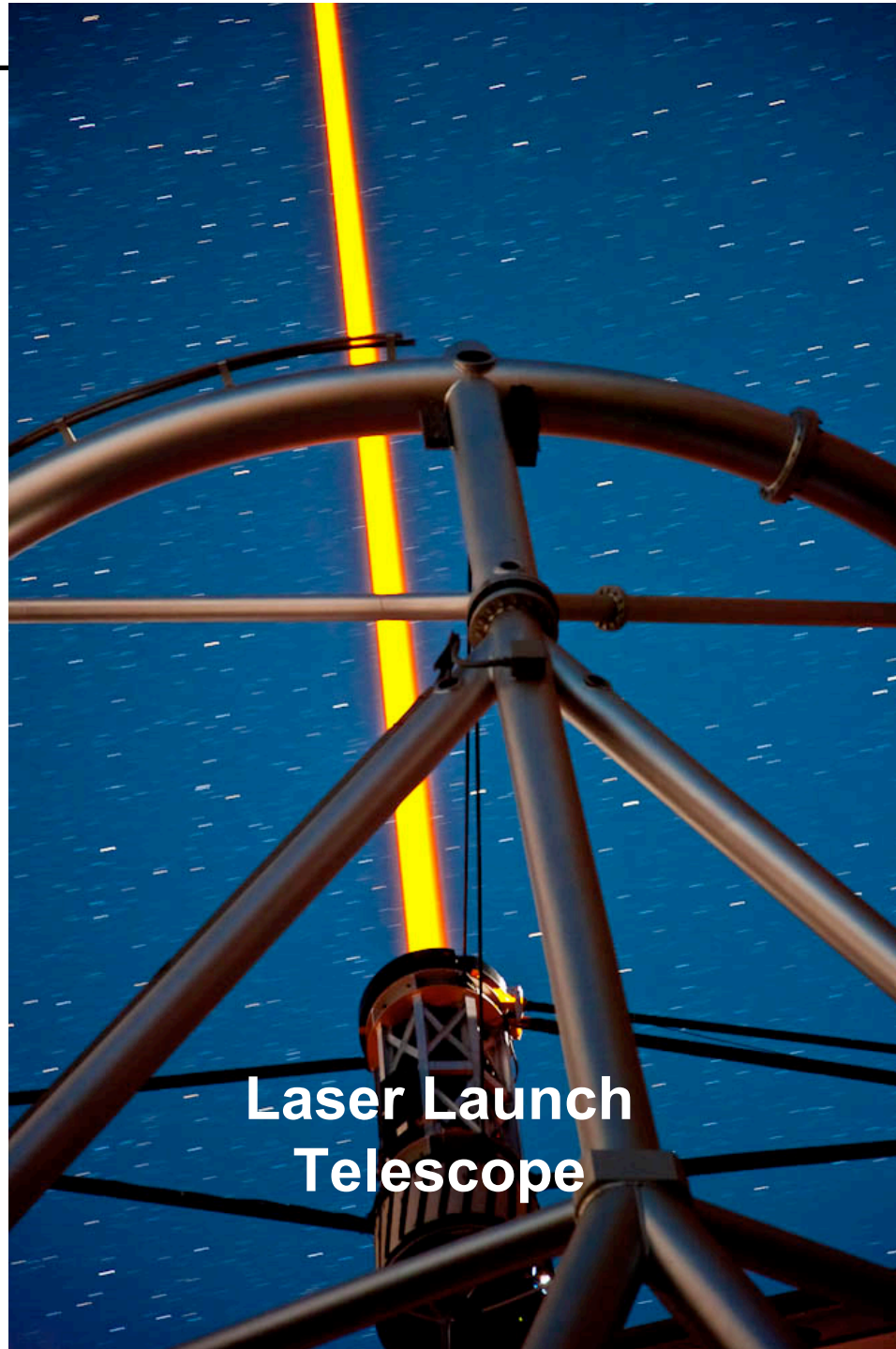
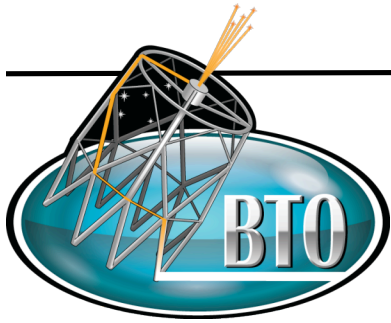
FWHM rms = 0.002"



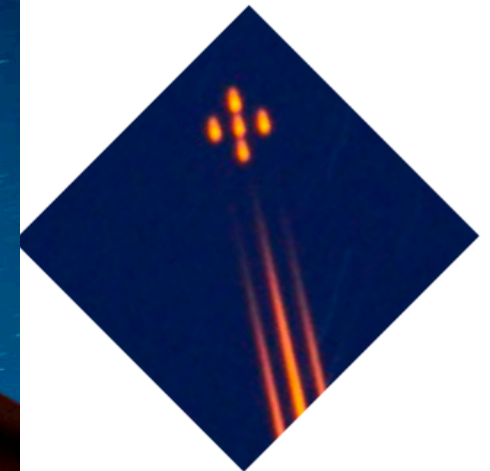
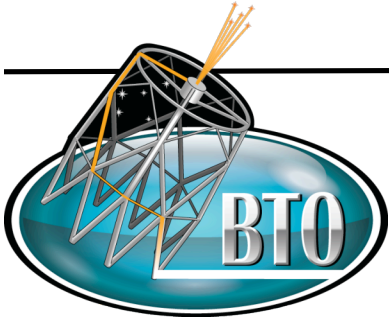


Beam Transfer Optic

50W Laser

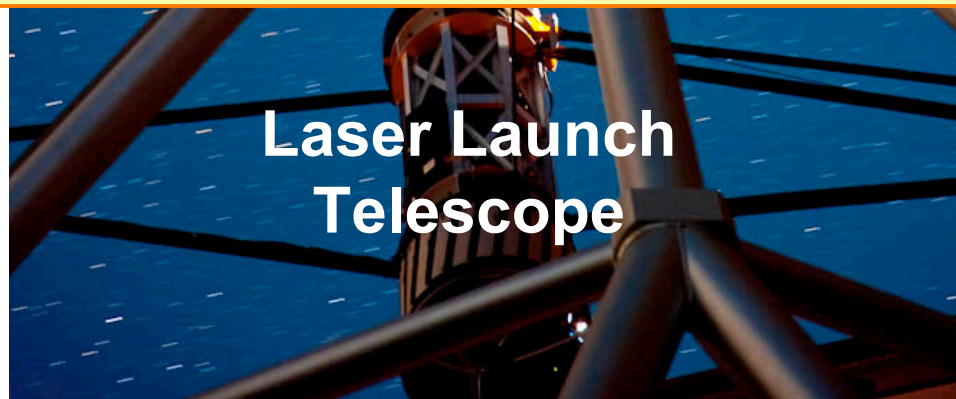


5 LGS
constellation



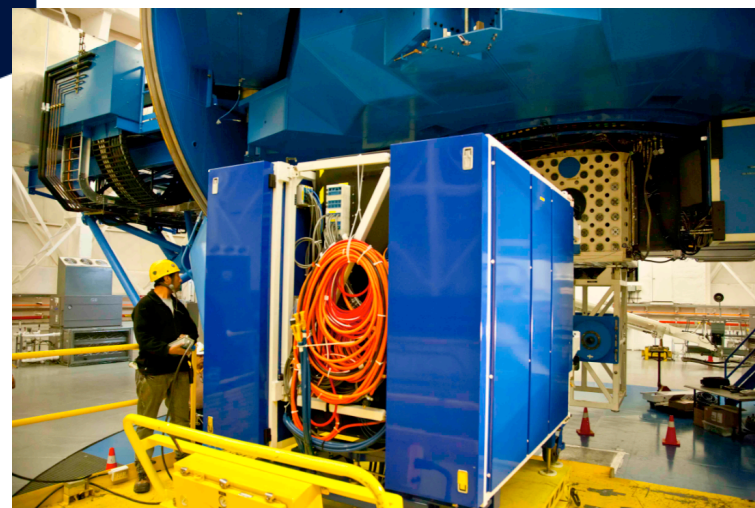
5 LGS
constellation

See d'Orgeville et al. "GeMS Laser Guide Star Facility
on-sky performance results" - Thursday @ 11h40





To science instruments



Instruments fed by GeMS

GSAOI

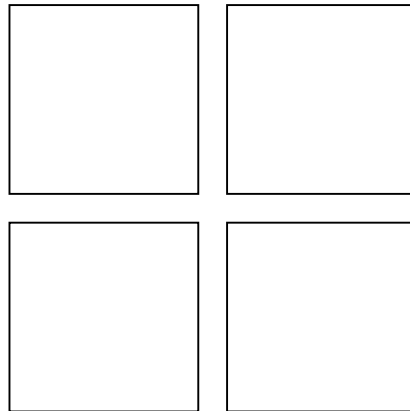
Near-Infrared wide field imager

2 x 2 mosaic Rockwell HAWAII-2RG 2048 x 2048 arrays

0.9 - 2.4 μm wavelength

85" x 85" field-of-view

Pix. scale of 0.02"/pixel



See Carrasco et al. "GSAOI commissioning results"

Flamingos-2

Near-Infrared wide field imager and multi-object spectrometer

0.95-2.4 μm wavelength

FoV = 120" diameter

Pix. Scale 0.09 arcsec/pix

Long Slit (slit width from 1 to 8 pixels)

MOS (custom masks)

R = 1200-3000

GMOS

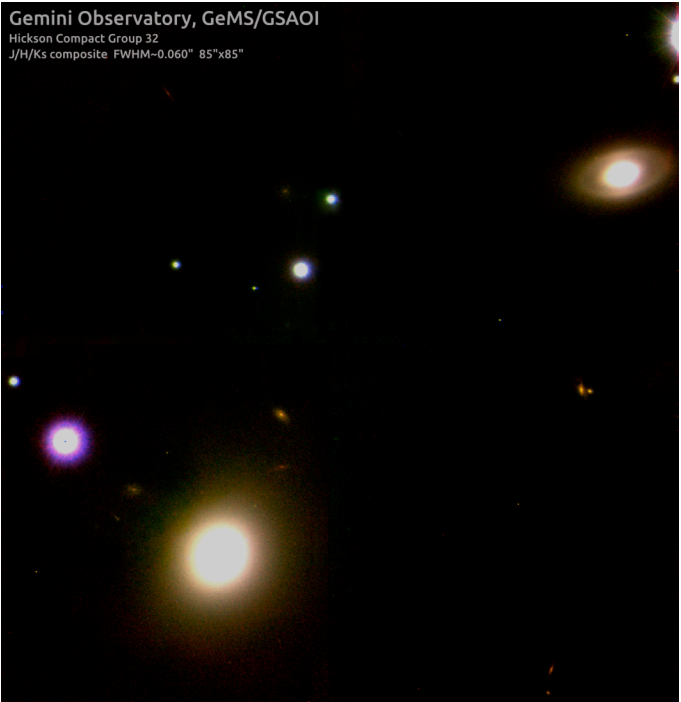
0.36-0.94 μm (New Hamamatsu-Red-Sensitive CCDs)
Imaging, long-slit and multi-slit spectroscopy

FoV = 2.4 arcminute diameter.

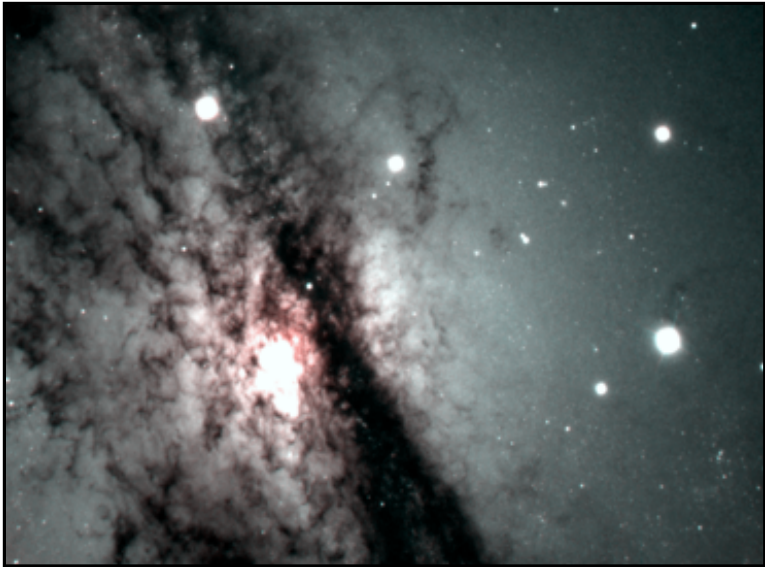
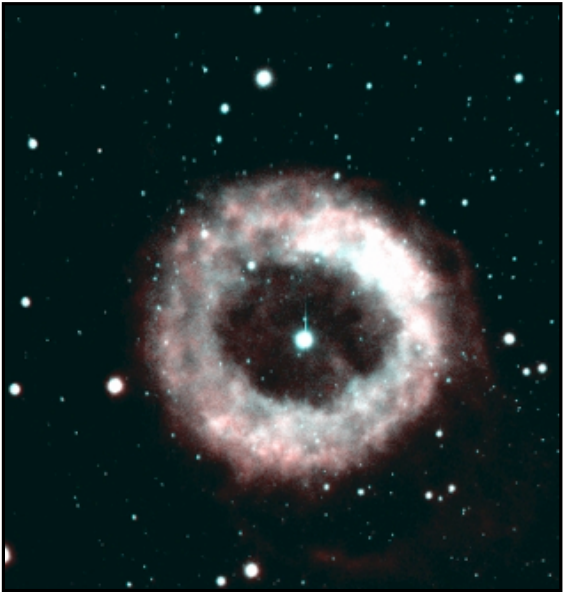
Integral Field Unit (IFU) - pix = 0.1arcsec - FoV = 17arcsec - R150 to 1200

GeMS gallery (first portraits)

GSAOI



GMOS



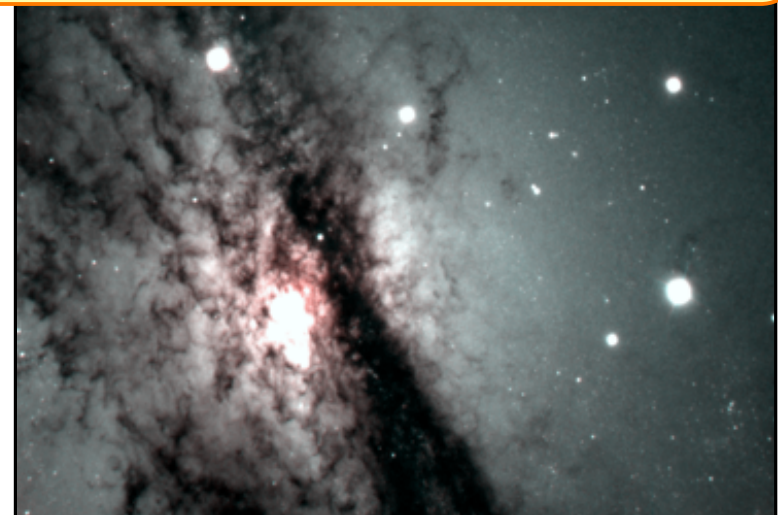
GeMS gallery (first portraits)

GSAOI



Performance is discussed in
Rigaut et al. "GeMS on-sky results"

GMOS



1.5 year of commissioning in a nutshell

Commissioning numbers

81 nights allocated for GeMS - 14.5 lost to weather - 12.5 lost to technical issues

2011

January							February							March							
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	
						1			1	2	3	4	5			1	2	3	4	5	
2	3	4	5	6	7	8	6	7	8	9	10	11	12	6	7	8	9	10	11	12	
9	10	11	12	13	14	15	13	14	15	16	17	18	19	13	14	15	16	17	18	19	
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23	24	25	26	27	28	29	27	28						27	28	29	30	31			
30	31																				
April							May							June							
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	
					1	2	1	2	3	4	5	6	7			1	2	3	4		
3	4	5	6	7	8	9	8	9	10	11	12	13	14	5	6	7	8	9	10	11	
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24	25	26	27	28	29	30	29	30	31					26	27	28	29	30			
July							August							September							
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	
					1	2			1	2	3	4	5	6					1	2	3
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24	25	26	27	28	29	30	28	29	30	31				25	26	27	28	29	30		
31																					
October							November							December							
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	
						1			1	2	3	4	5			1	2	3	4	5	
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23	24	25	26	27	28	29	27	28	29	30				25	26	27	28	29	30	31	
30	31																				

HTTP://WWW.PRINTEREE.COM

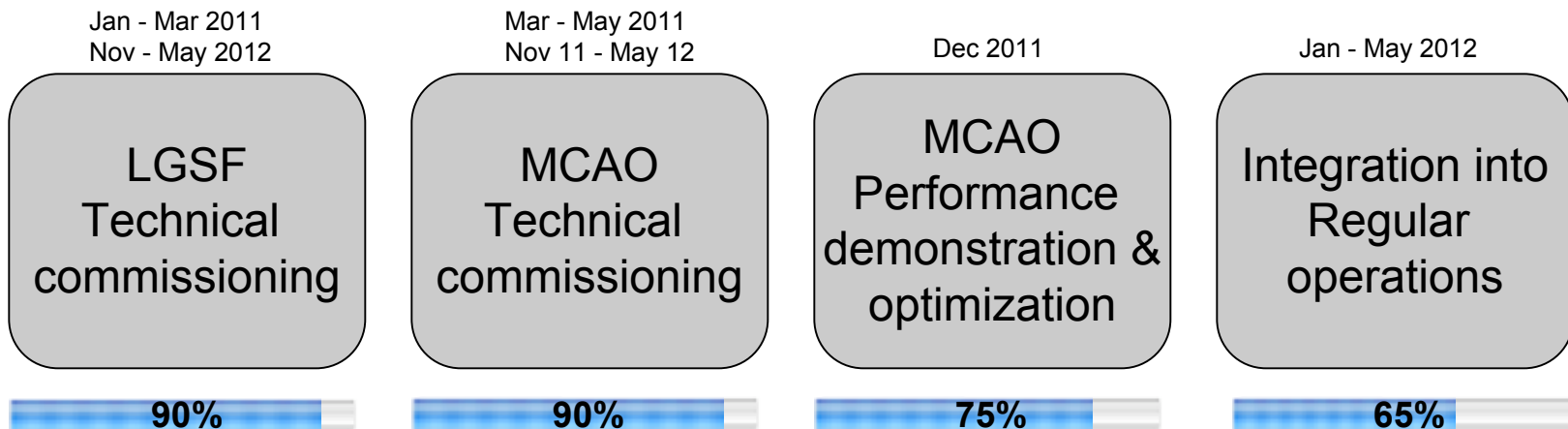
2012

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29	30	31					26	27	28	29				25	26	27	28	29	30	31
April							May							June						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7			1	2	3	4	5			1	2	3	4	5
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29	30	31					27	28	29	30	31			24	25	26	27	28	29	30
July							August							September						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7			1	2	3	4							1	2
8	9	10	11	12	13	14	5	6	7	8	9	10	11	2	3	4	5	6	7	8
15	16	17	18	19	20	21	12	13	14	15	16	17	18	9	10	11	12	13	14	15
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29	30	31					26	27	28	29	30	31		23	24	25	26	27	28	29
October							November							December						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7			1	2	3	4	5			1	2	3	4	5
8	9	10	11	12	13	14	6	7	8	9	10	11	12	4	5	6	7	8	9	10
15	16	17	18	19	20	21	13	14	15	16	17	18	19	11	12	13	14	15	16	17
22	23	24	25	26	27	28	20	21	22	23	24	25	26	18	19	20	21	22	23	24
29	30	31					27	28	29	30				25	26	27	28	29	30	31

HTTP://WWW.PRINTEREE.COM

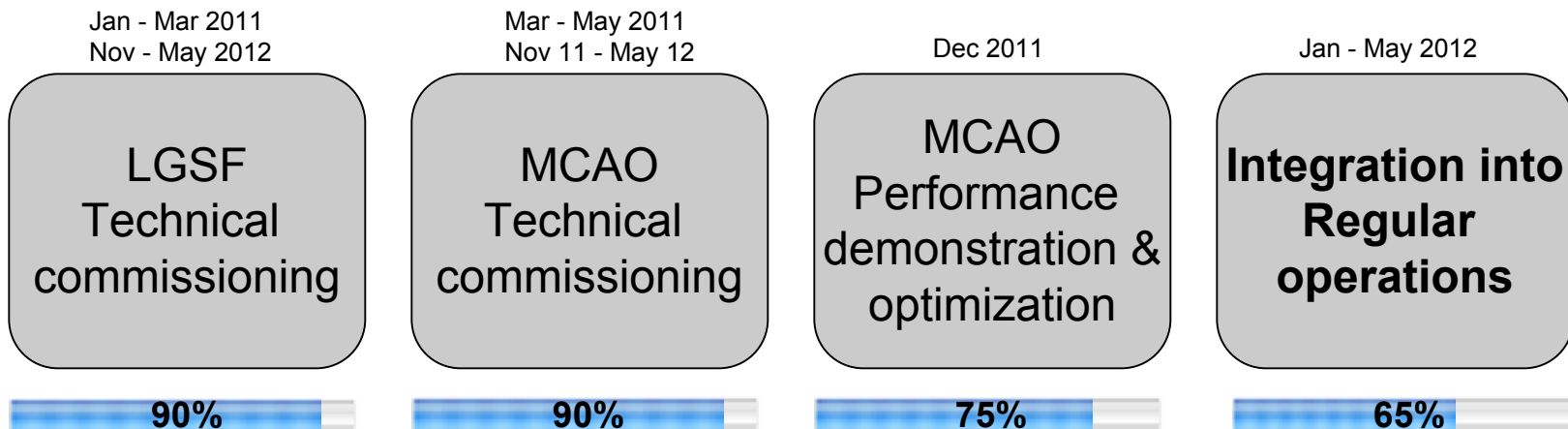
Commissioning Status

What has been done:



Commissioning Status

What has been done:



From commissioning to operations

“Regular” operations = 2 persons to operate GeMS



1 Telescope operator



1 Laser operator

From commissioning to operations

“Regular” operations = 2 persons to operate GeMS



1 Telescope operator



1 Laser operator

5 LGS
3 NGS
1 SFS
1 Flexure

~ 20 loops

Goal: Minimize system complexity - Minimize overheads

Ex. Acquisition procedure...

Acquisition procedure

Step1: Telescope slew and mechanisms in follow
Where all the LUTs are crucial...



This step	1min	2min
total	1min	2min

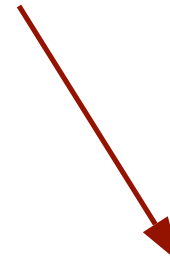
Acquisition procedure

Step1: Telescope slew and mechanisms in follow

Where all the LUTs are crucial...



This step	1min	2min
total	1min	2min



Step2A: Laser alignment



Step2B: NGS alignment



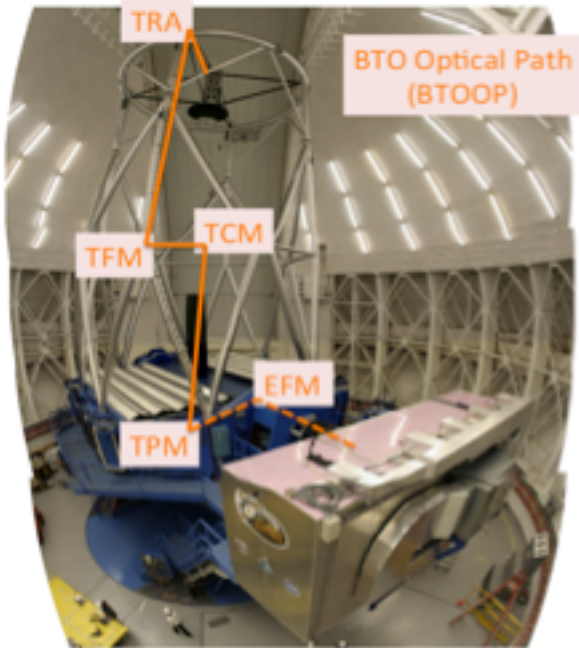
Acquisition procedure

Step2A: Laser alignment

1. Alignment in the BTO



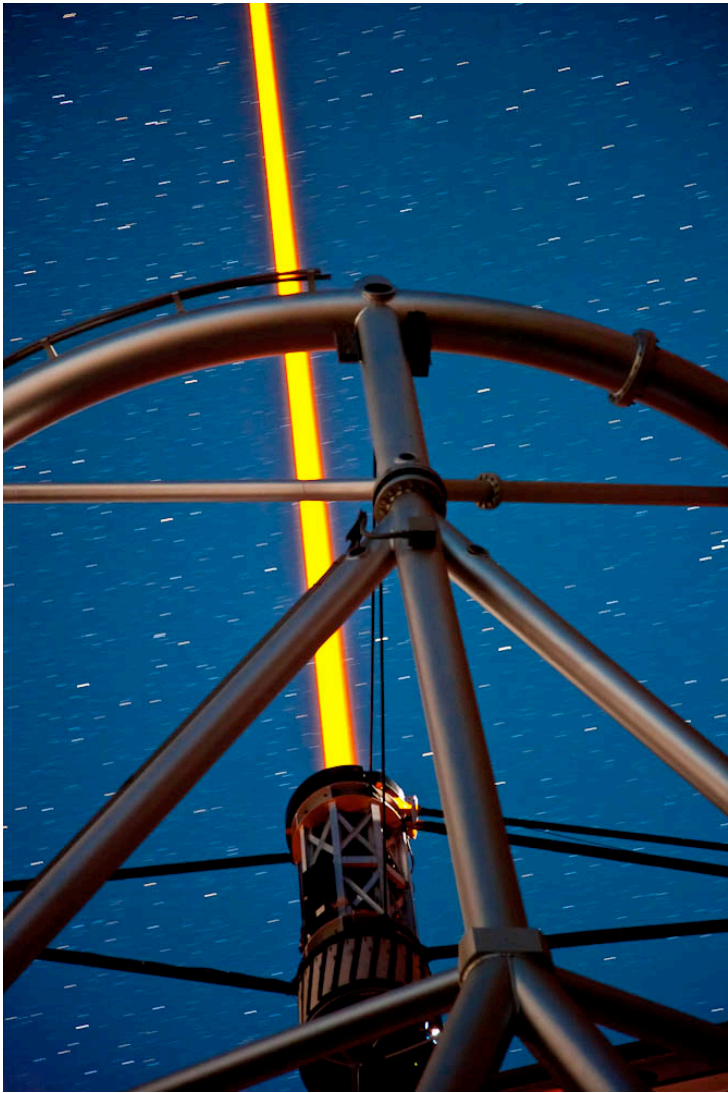
This step	2min	4min
total	3min	6min



Acquisition procedure

Step2A: Laser alignment

2. *Permission to propagate*



This step	1min	2min
total	4min	8min

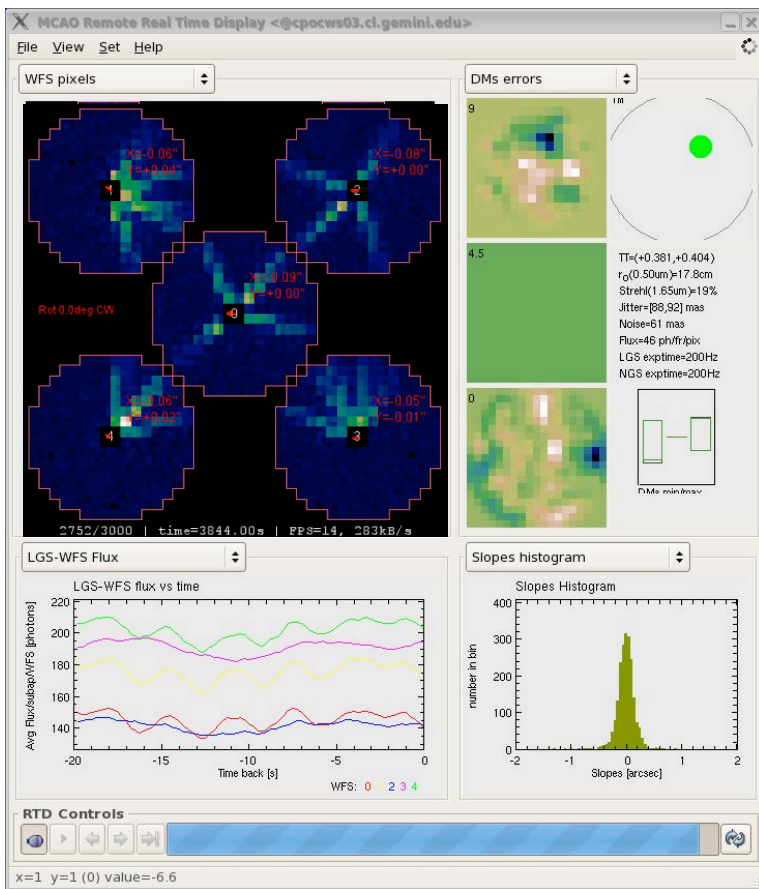
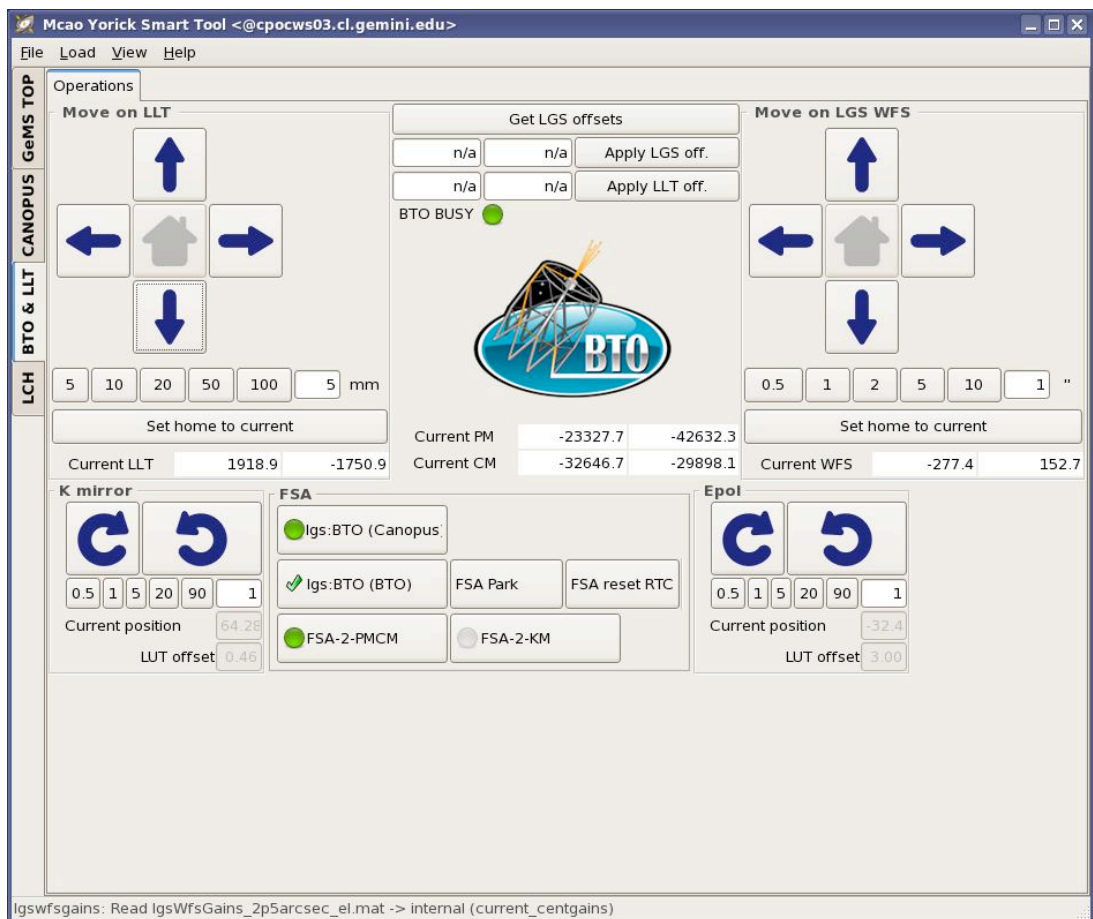
Acquisition procedure

Step2A: Laser alignment

3. LGS alignment on the LGSWFS



This step	1min	2min
total	5min	10min



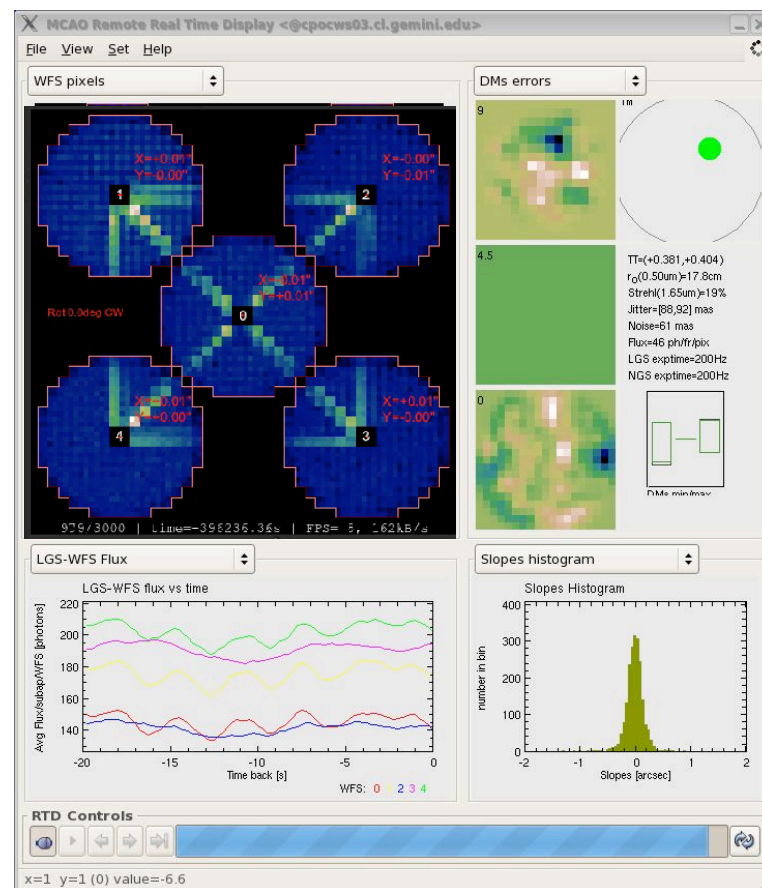
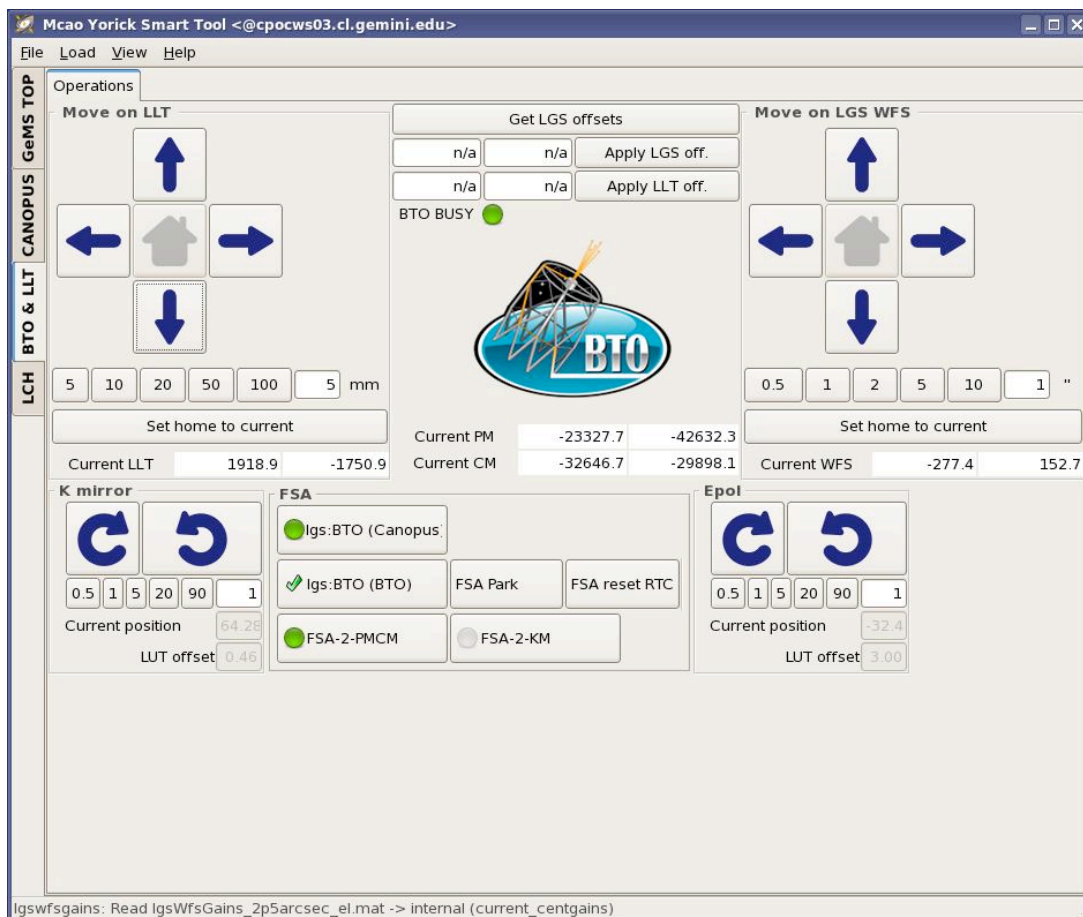
Acquisition procedure

Step2A: Laser alignment

3. LGS alignment on the LGSWFS



This step	1min	2min
total	5min	10min

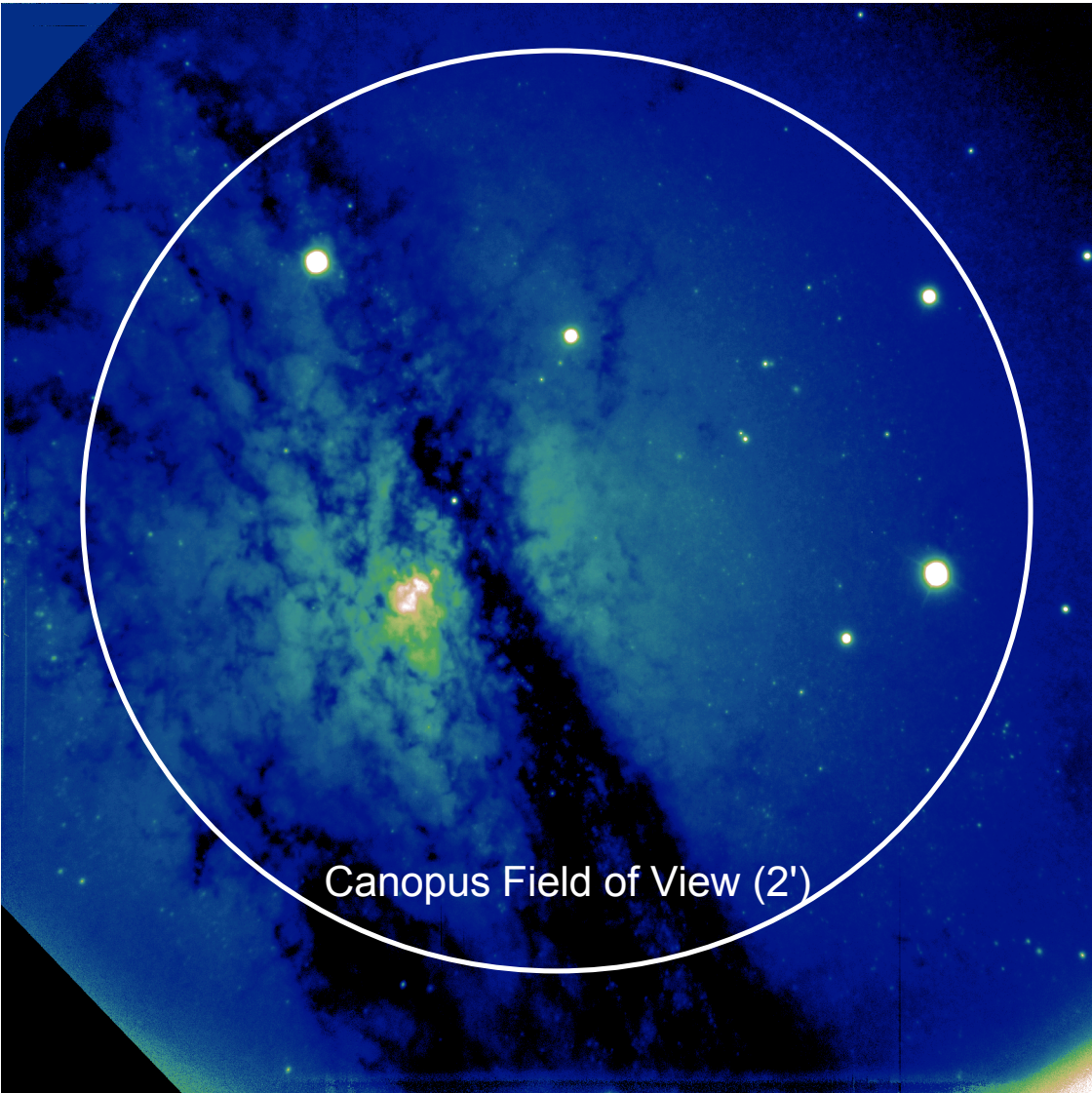


Acquisition procedure

Step2B: NGS alignment



This step	1min	2min
total	1min	2min

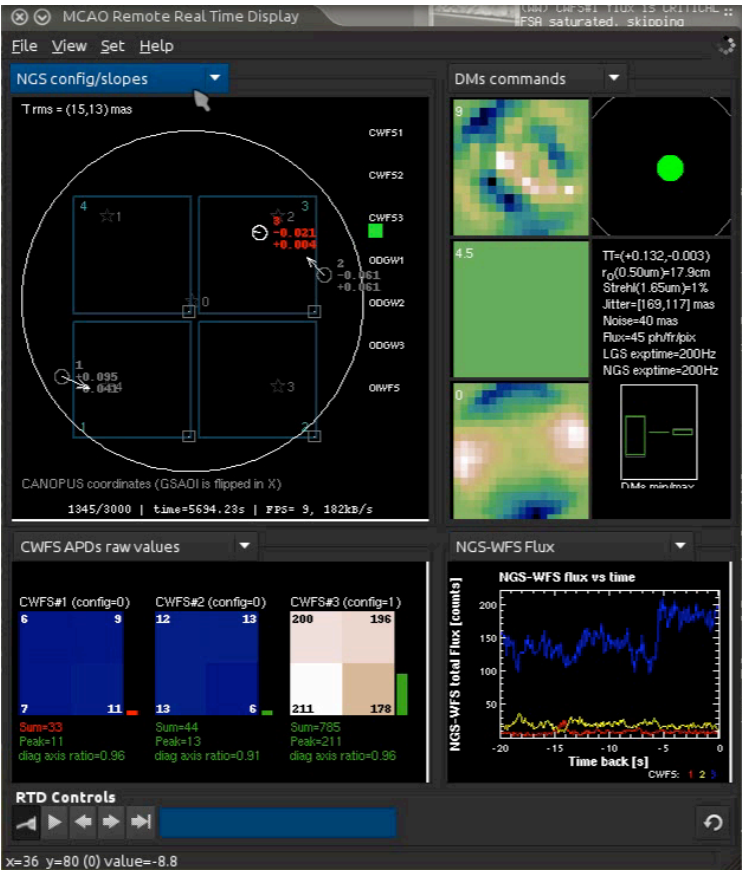
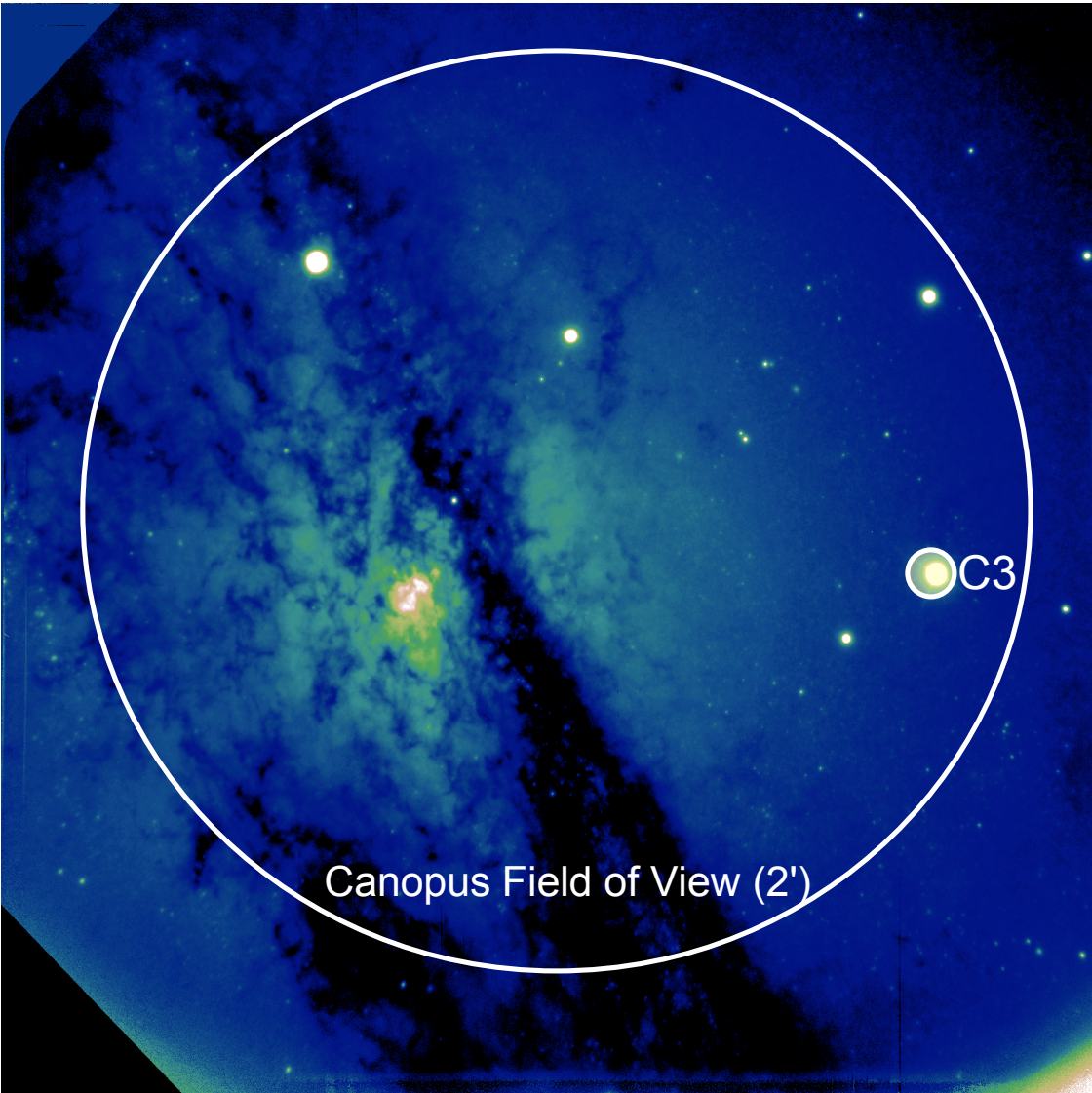


Acquisition procedure

Step2B: NGS alignment



This step	2min	4min
total	3min	6min

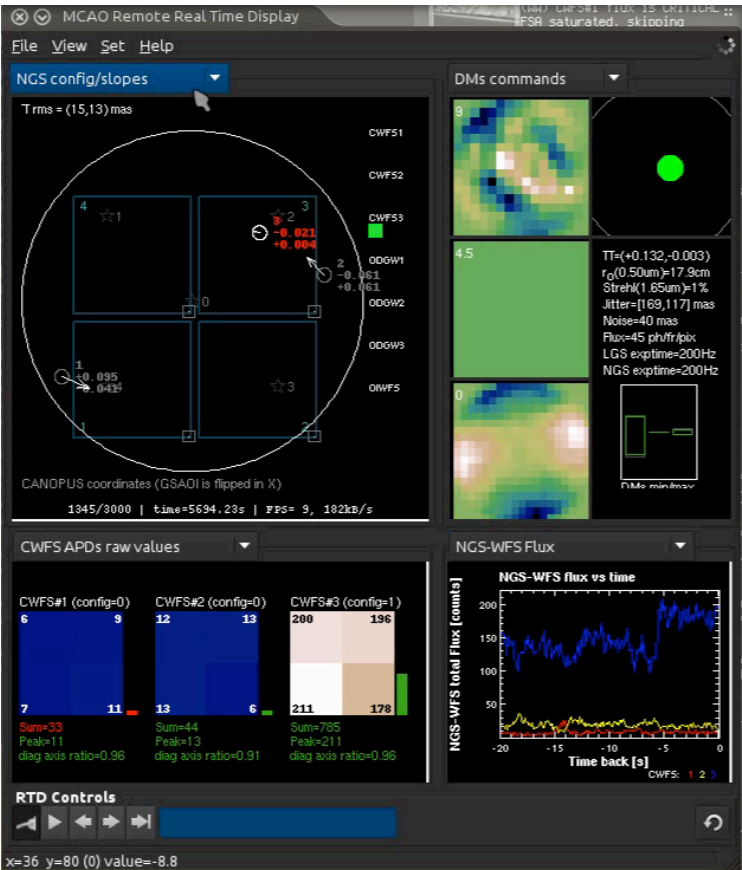
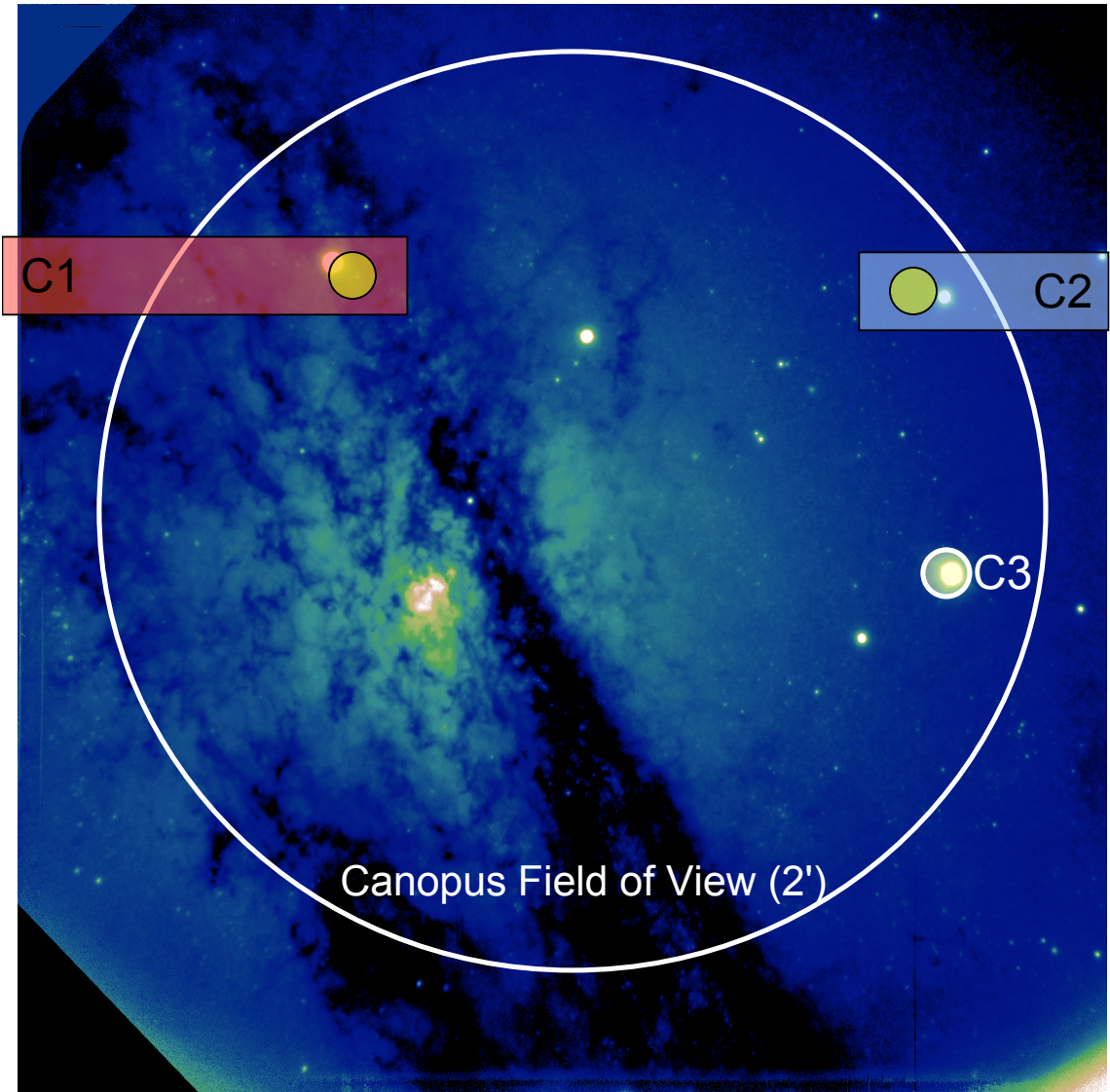


Acquisition procedure

Step2B: NGS alignment



This step	5min	20min
total	8min	26min

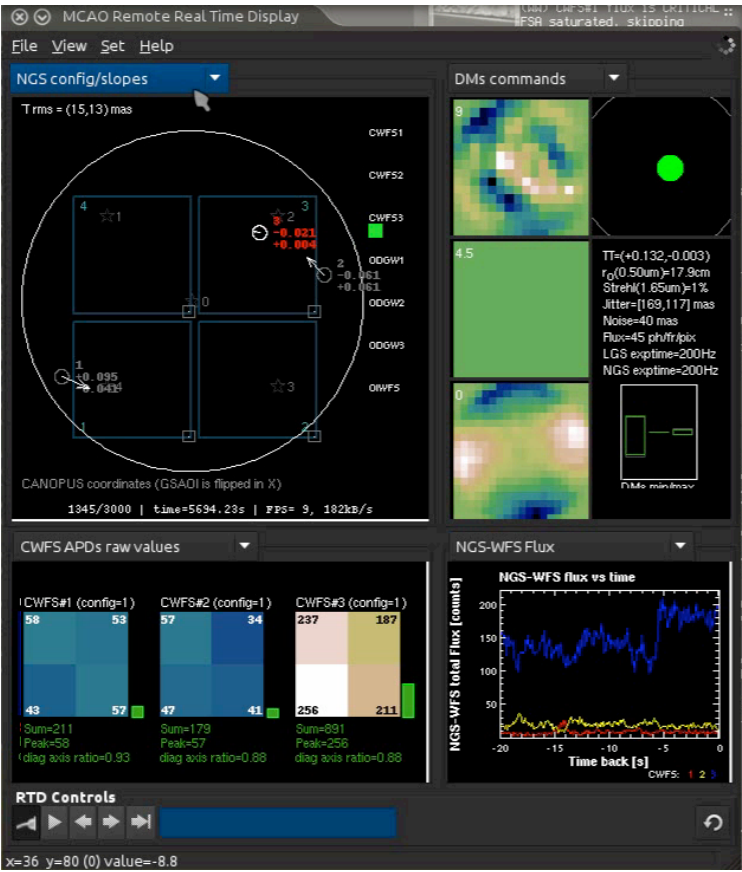
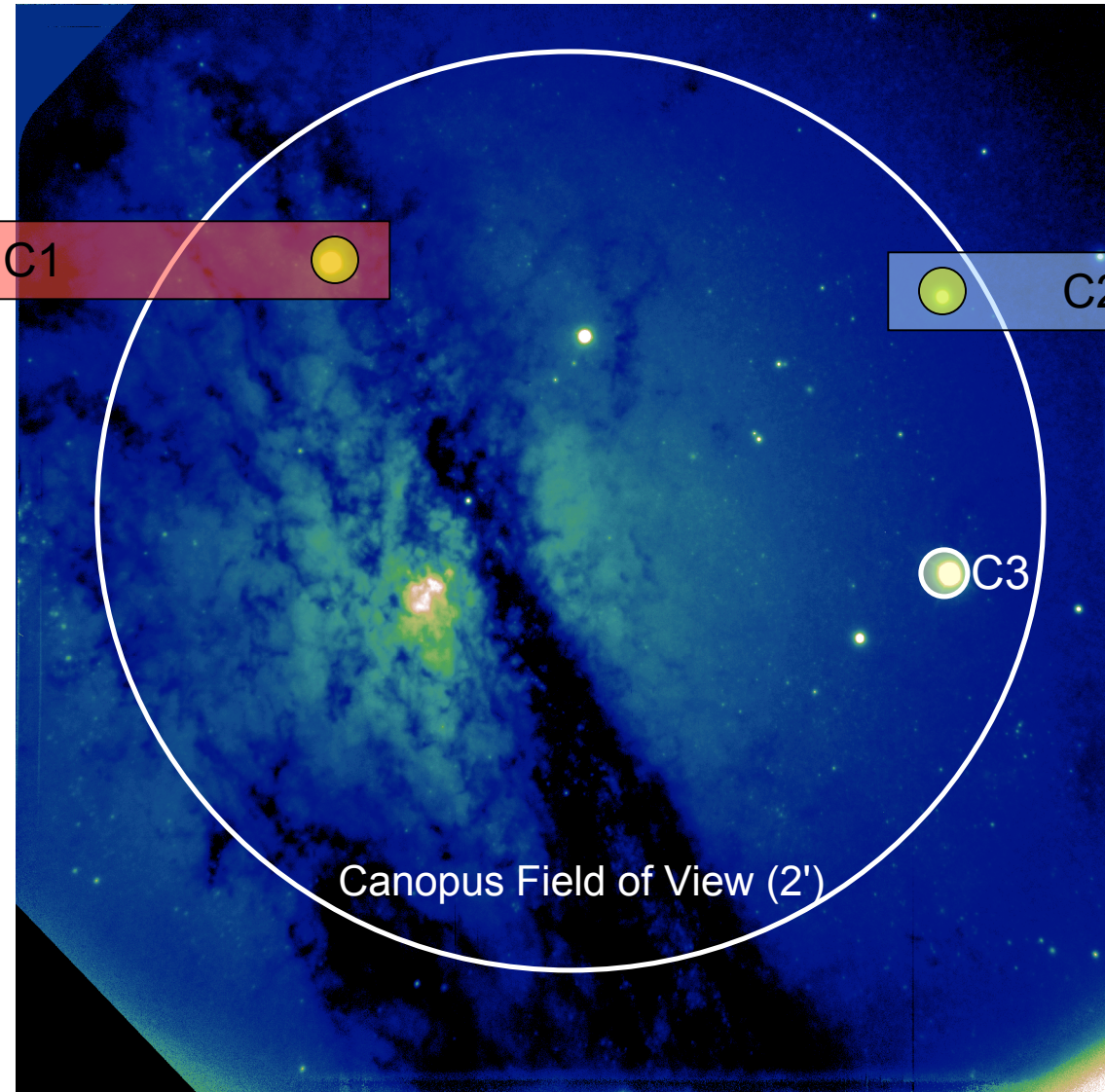


Acquisition procedure

Step2B: NGS alignment

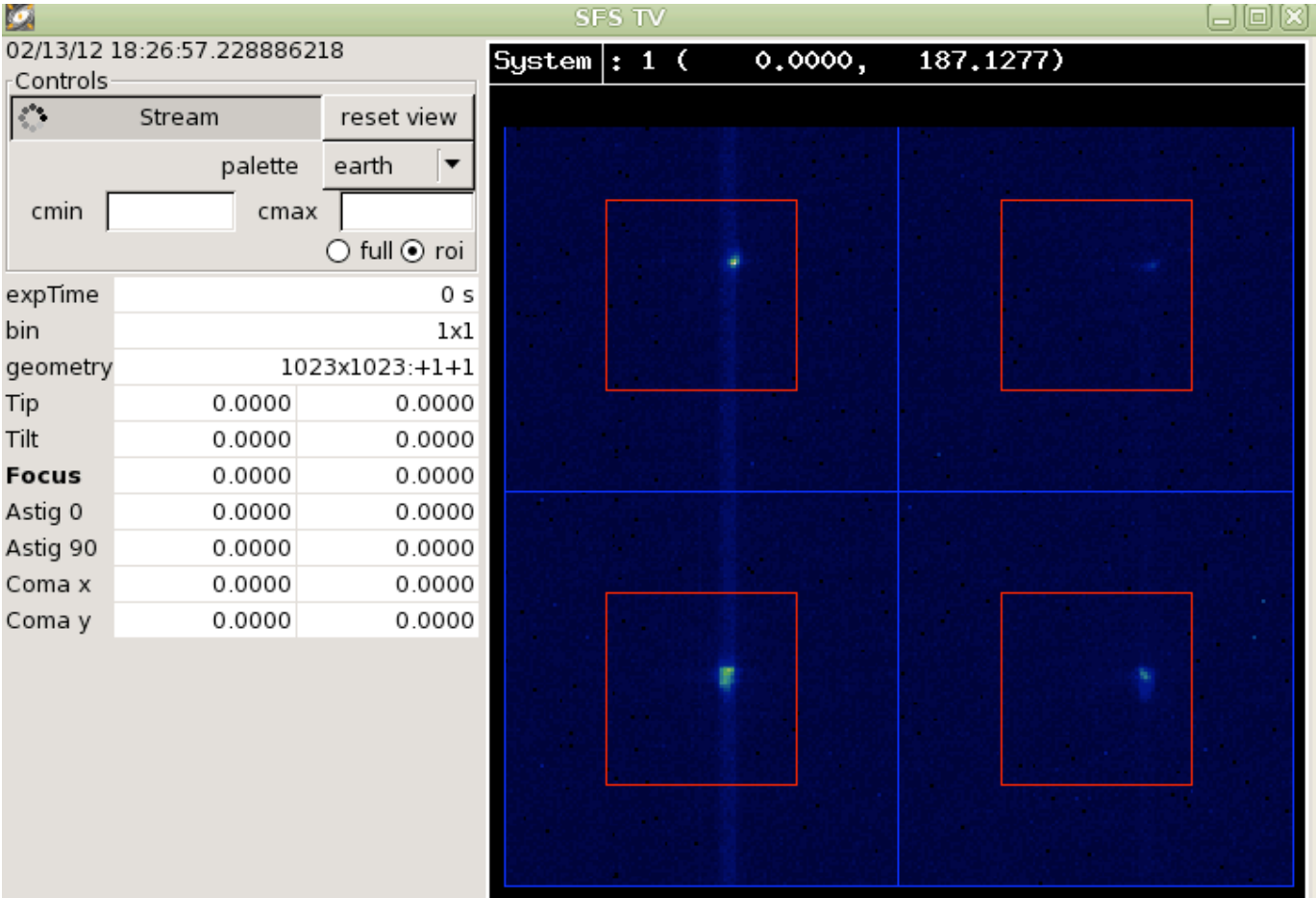


This step	5min	20min
total	8min	26min



Acquisition procedure

Step3: Slow Focus Sensor - Focus loop



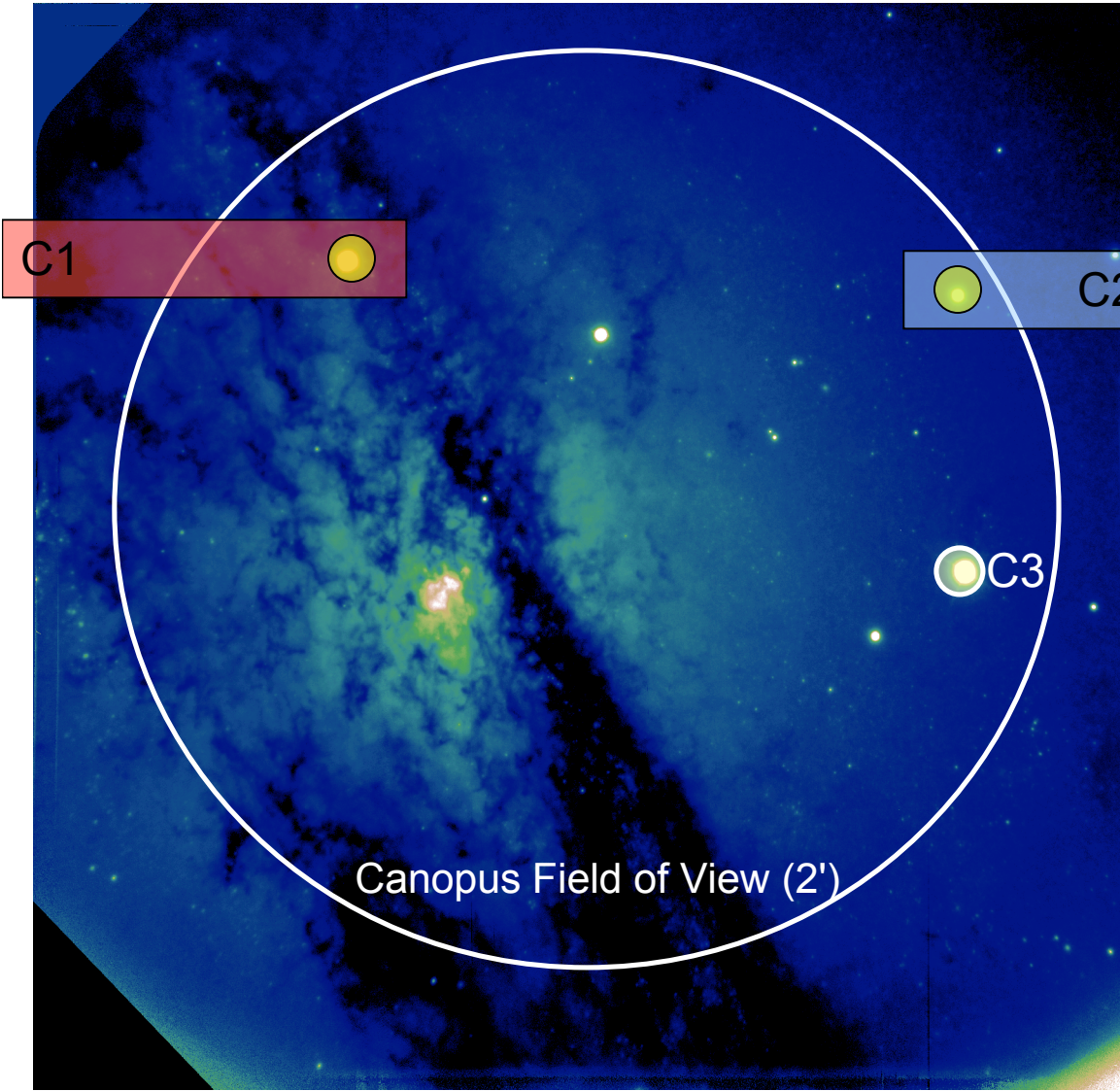
This step	2min	4min
total	10min	30min

Acquisition procedure

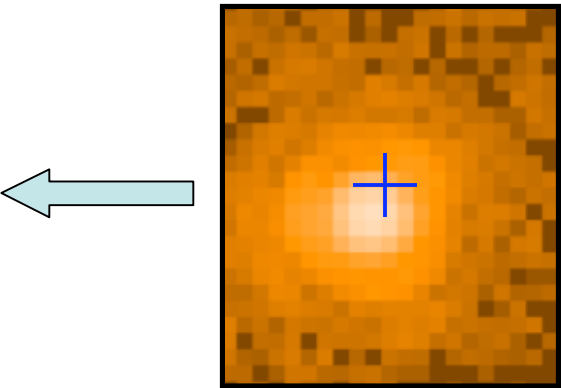
Step4: Flexure loop



This step	2min	5min
total	12min	35min

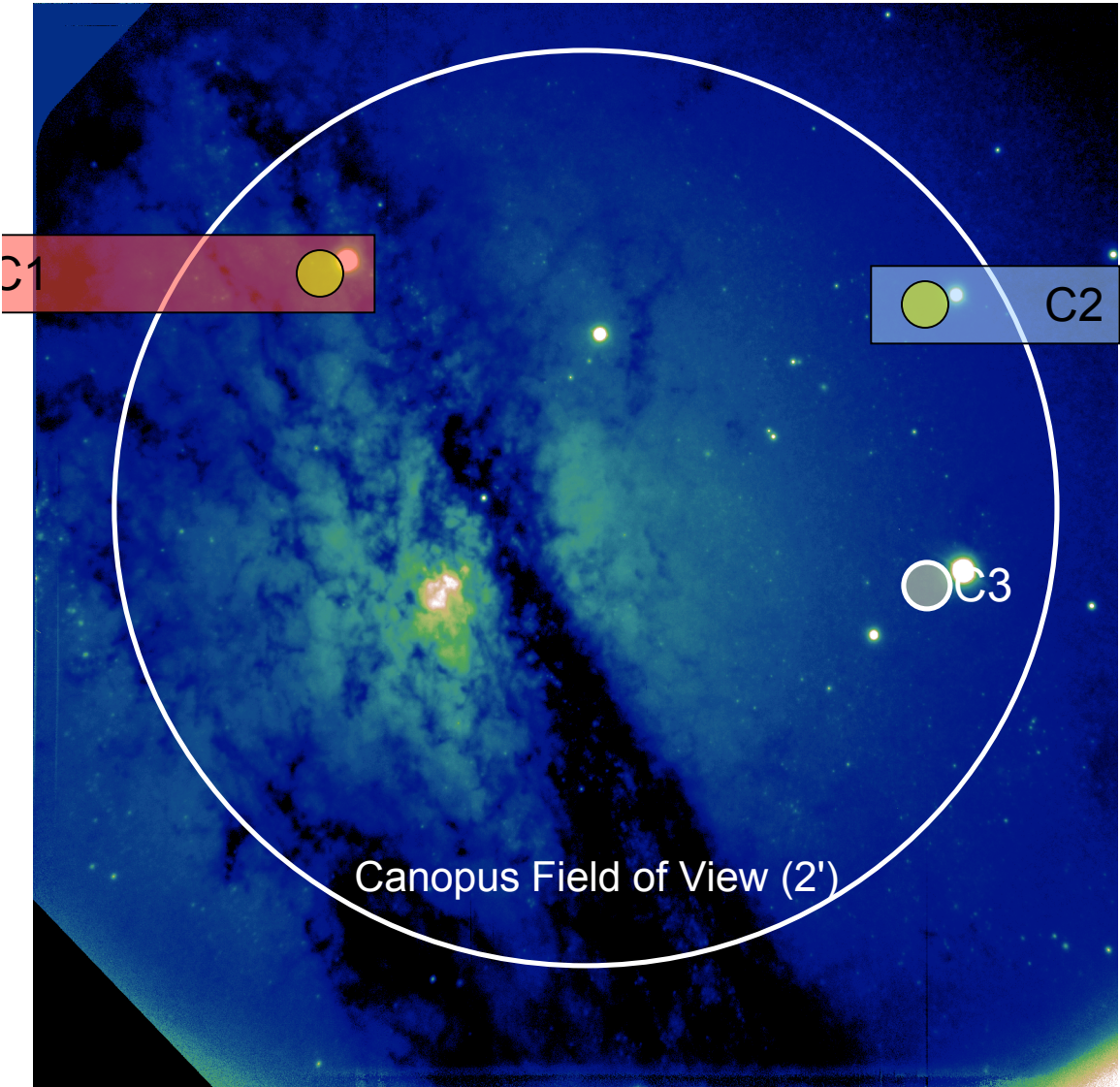


On-Instrument WFS



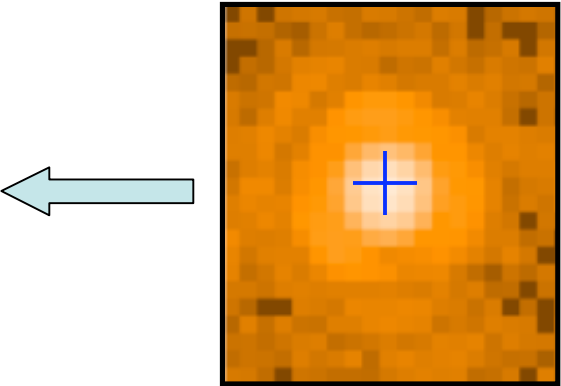
Acquisition procedure

Step4: Flexure loop



This step	2min	5min
total	12min	35min

On-Instrument WFS

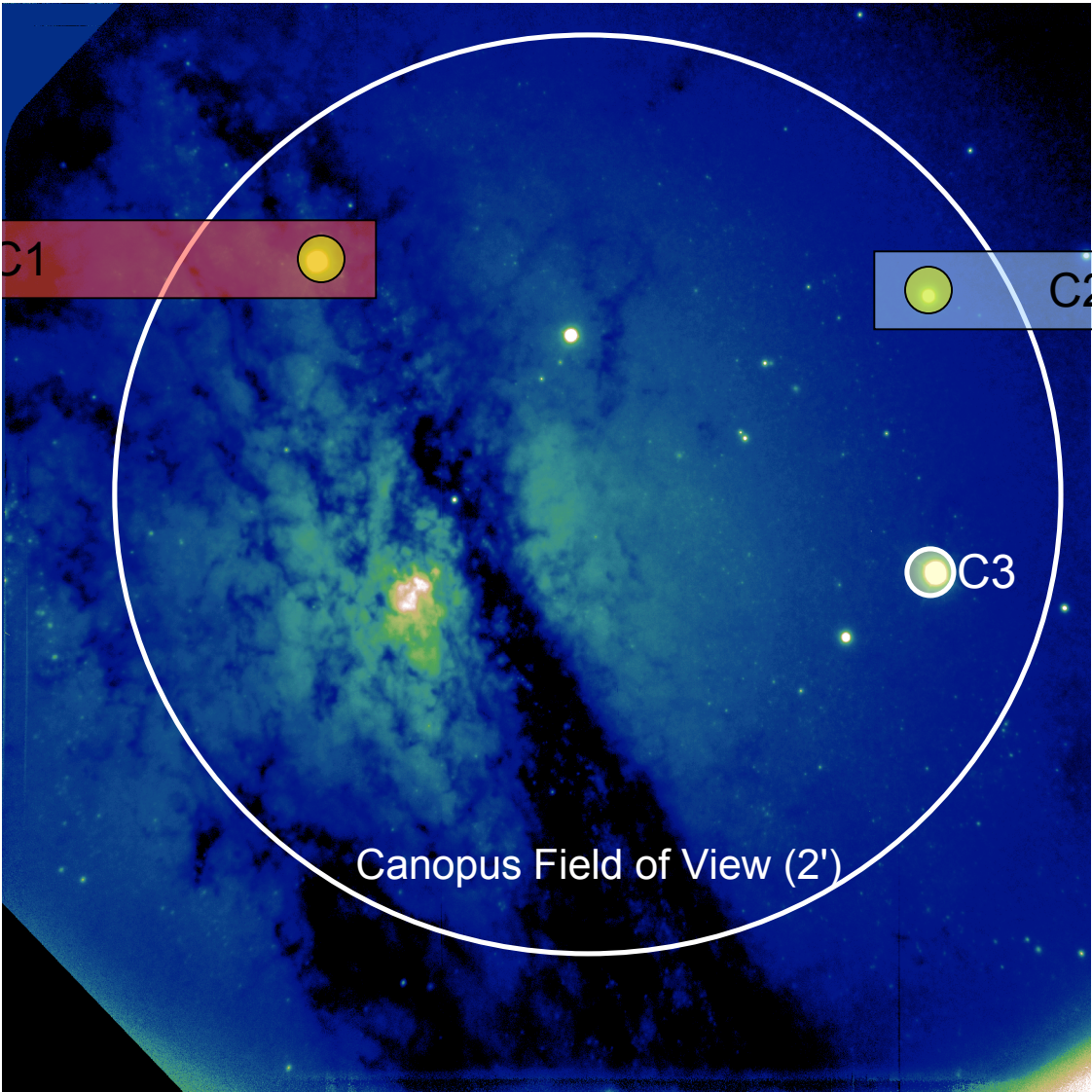


Acquisition procedure

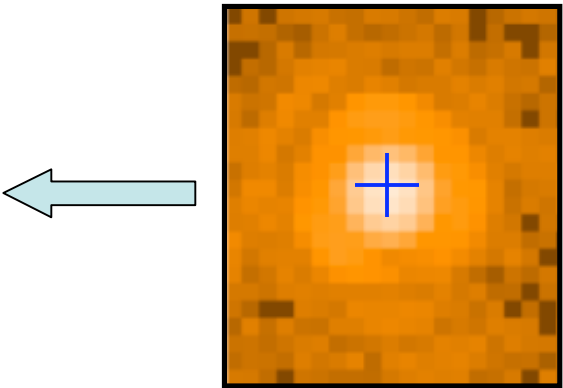
Step4: Flexure loop



This step	2min	5min
total	12min	35min

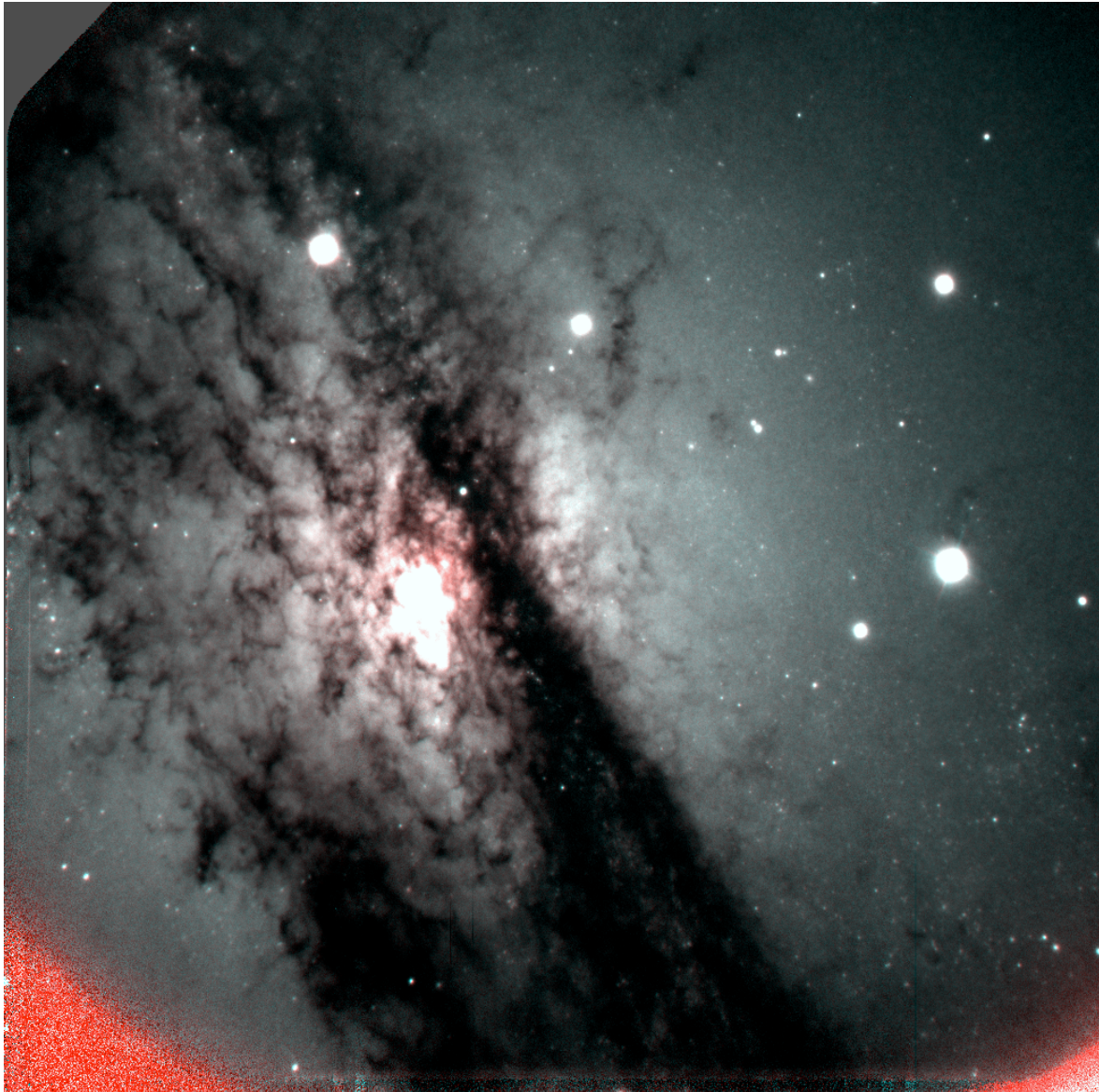


On-Instrument WFS



Acquisition procedure

Step5: Science Ready !



	Best	Worst
Total	12min	35min

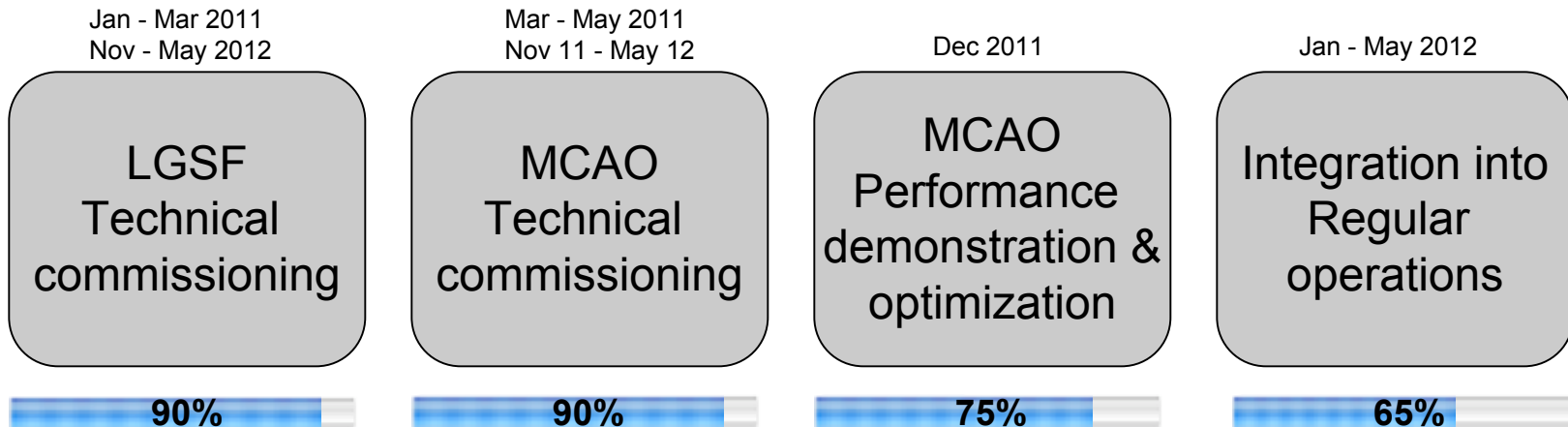
Acquisition procedure



Goal: Minimize system complexity - Minimize overheads

Commissioning Status

What has been done:

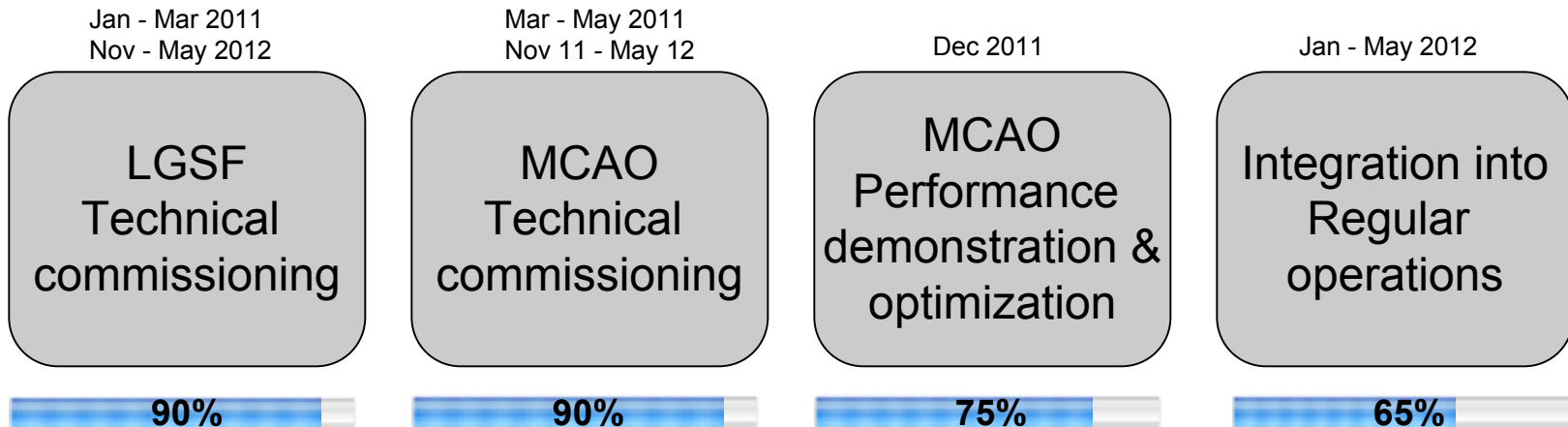


What's missing:

Power optimization Polarization control BTO throughput ...	ADC control Science dichroïc ...	GSAOI fast ODGW NGSWFS throughput Perf. Characterization Fratricide ...	Software Software Software ...
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Commissioning Status

What has been done:



What's missing:

Power optimization Polarization control BTO throughput ...	ADC control Science dichroïc ...	GSAOI fast ODGW NGSWFS throughput Perf. Characterization Fratricide ...	Software Software Software ...
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GSAOI ODGW fast Tip-Tilt

GSAOI

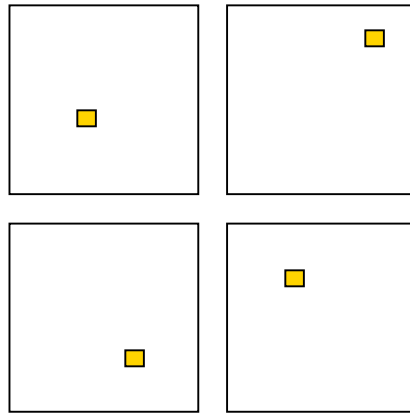
Near-Infrared wide field imager

2 x 2 mosaic Rockwell HAWAII-2RG 2048 x 2048 arrays

0.9 - 2.4 μm wavelength

85" x 85" field-of-view

Pix. scale of 0.02"/pixel



See Young et al. "Using ODGWs with GSAOI:
software and firmware implementation challenges"
8451-77

On Detector Guide Window

1 ODGW / array

Size = 2x2 to 128x128

Frame rate = up to 800Hz

GSAOI ODGW fast Tip-Tilt

GSAOI

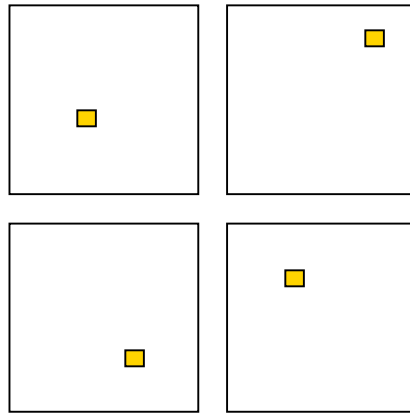
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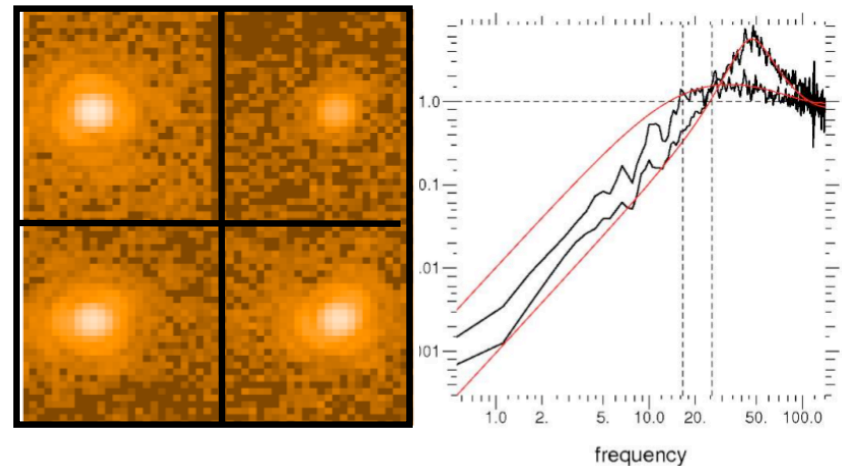
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GSAOI ODGW fast Tip-Tilt

GSAOI

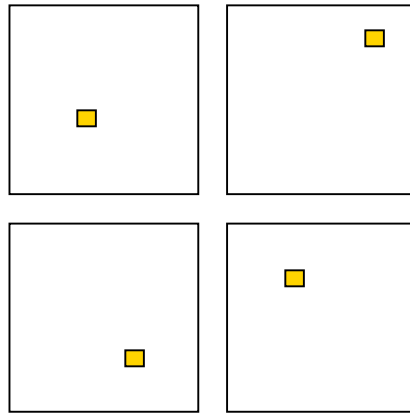
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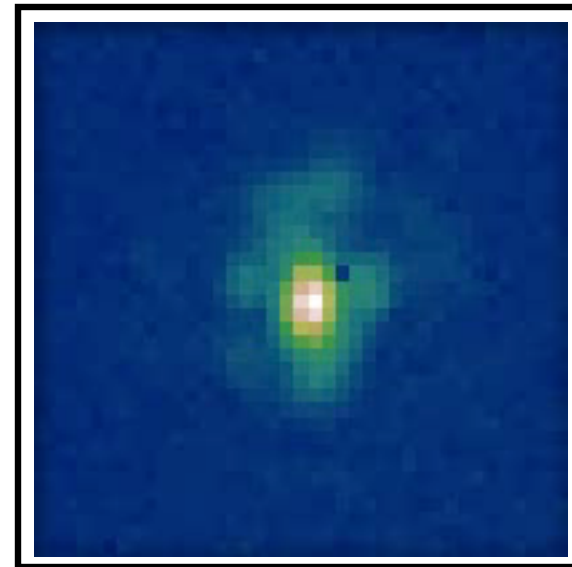


On Detector Guide Window

1 ODGW / array

Size = 2x2 to 128x128

Frame rate = up to 800Hz



Use for NIR guiding, But also:

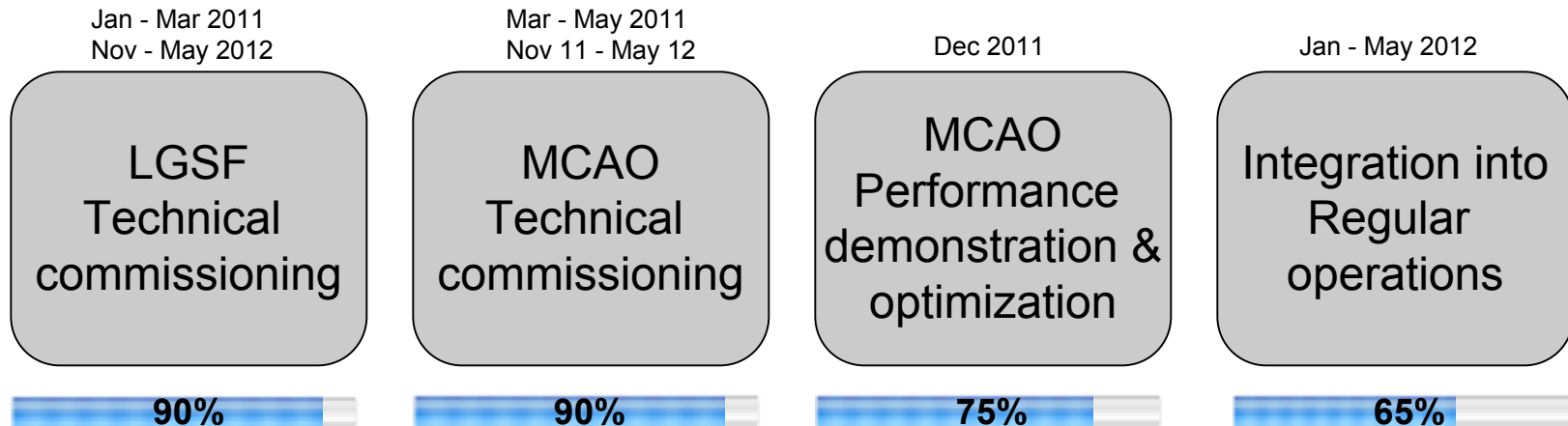
- On-line performance optimization
- Focus estimation ?
- PSF reconstruction ?

See C. Plantet et al. (ONERA) "LIFT" - Thursday @ 10h50 -8447-60

See L. Gilles et al. (TMT) - Friday @ 11h30 - 8447-81

Conclusions: is GeMS ready for Science ?

What has been done:



What's missing:

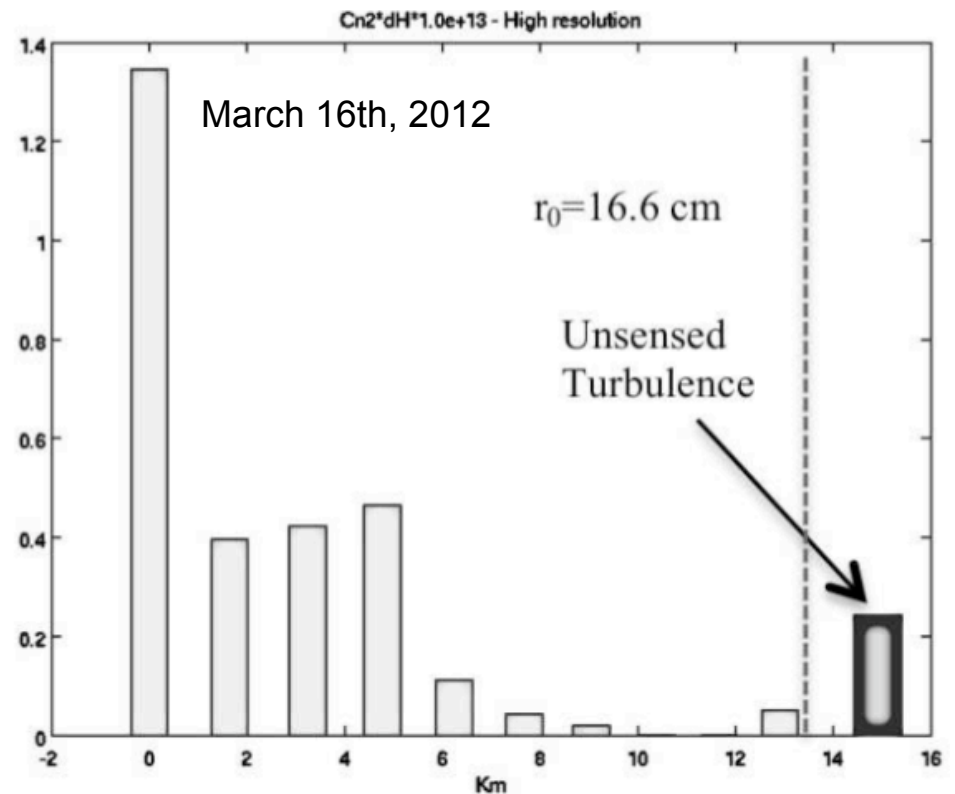
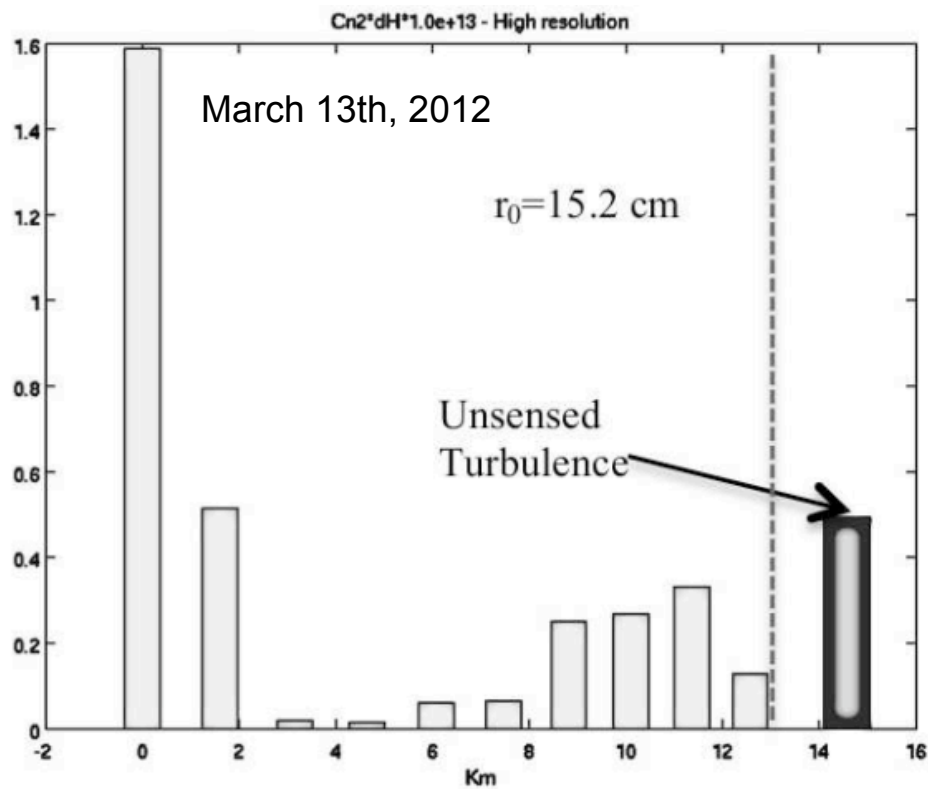
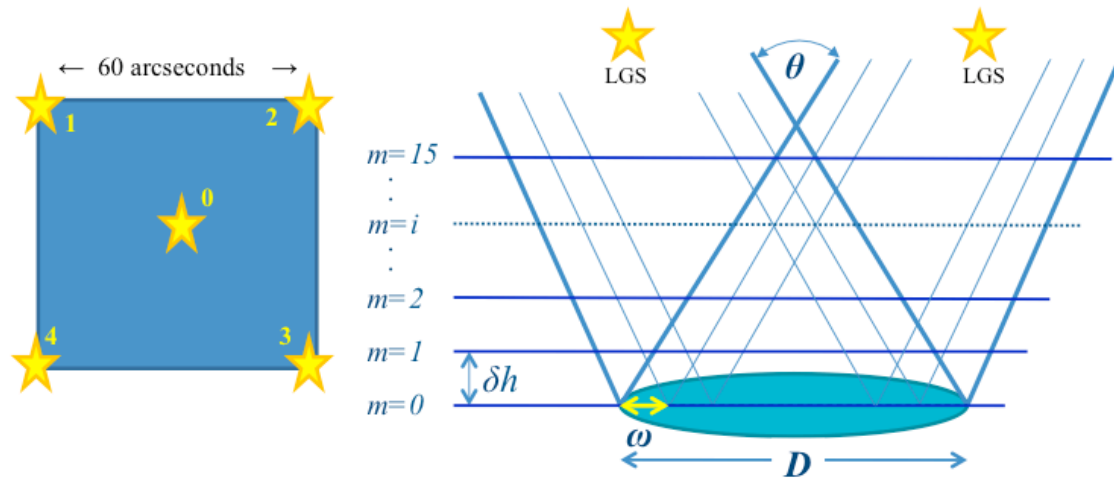
Power optimization Polarization control BTO throughput ...	ADC control Science dichroïc ...	GSAOI fast ODGW NGSWFS throughput Perf. Characterization Fratricide ...	Software Software Software ...
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GeMS new features:

- Integrated SLODAR
- Test of advanced controllers

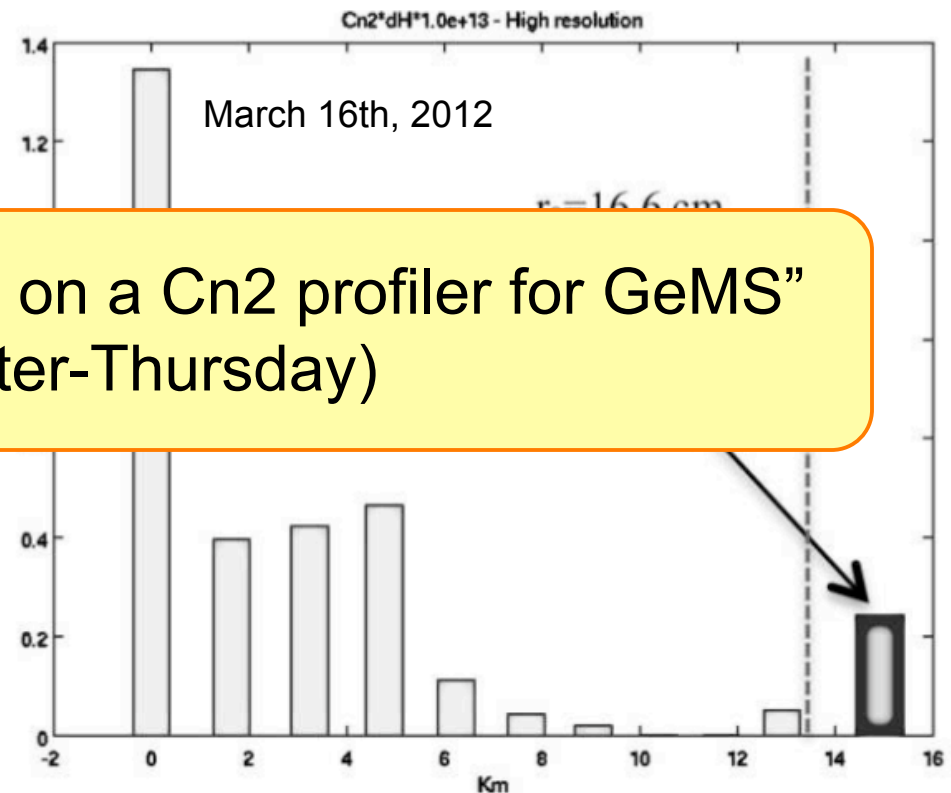
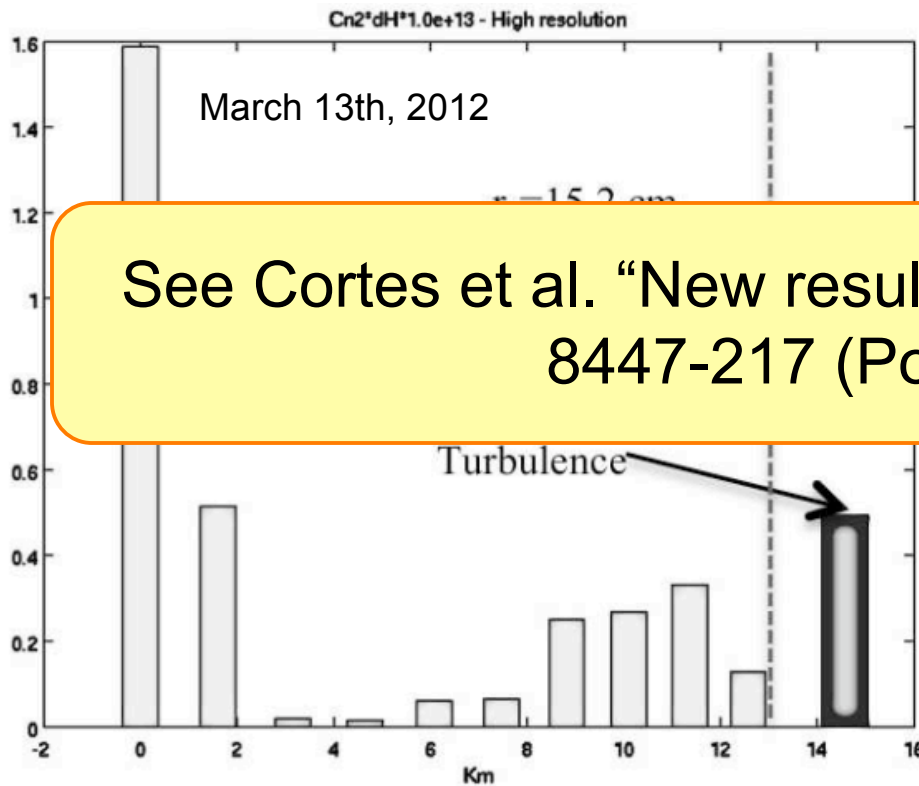
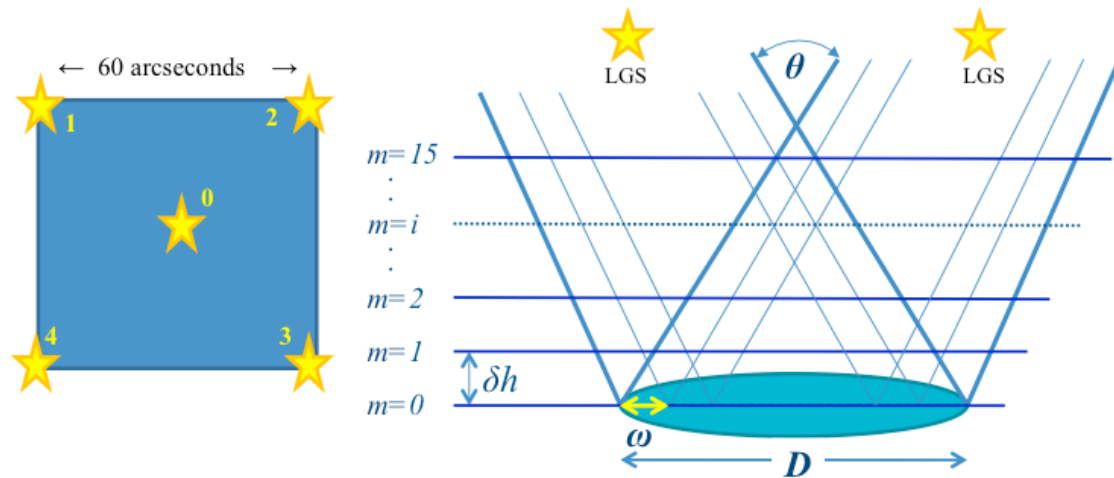
GeMS new features

Integrated SLODAR



GeMS new features

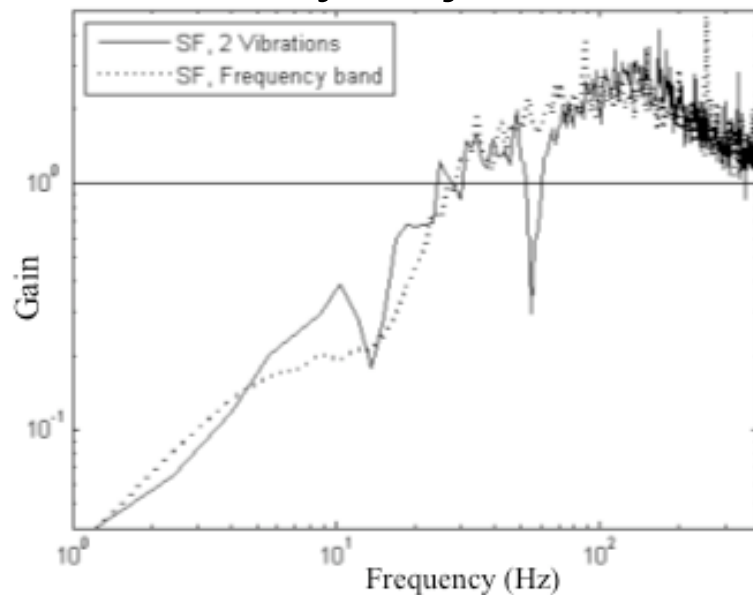
Integrated SLODAR



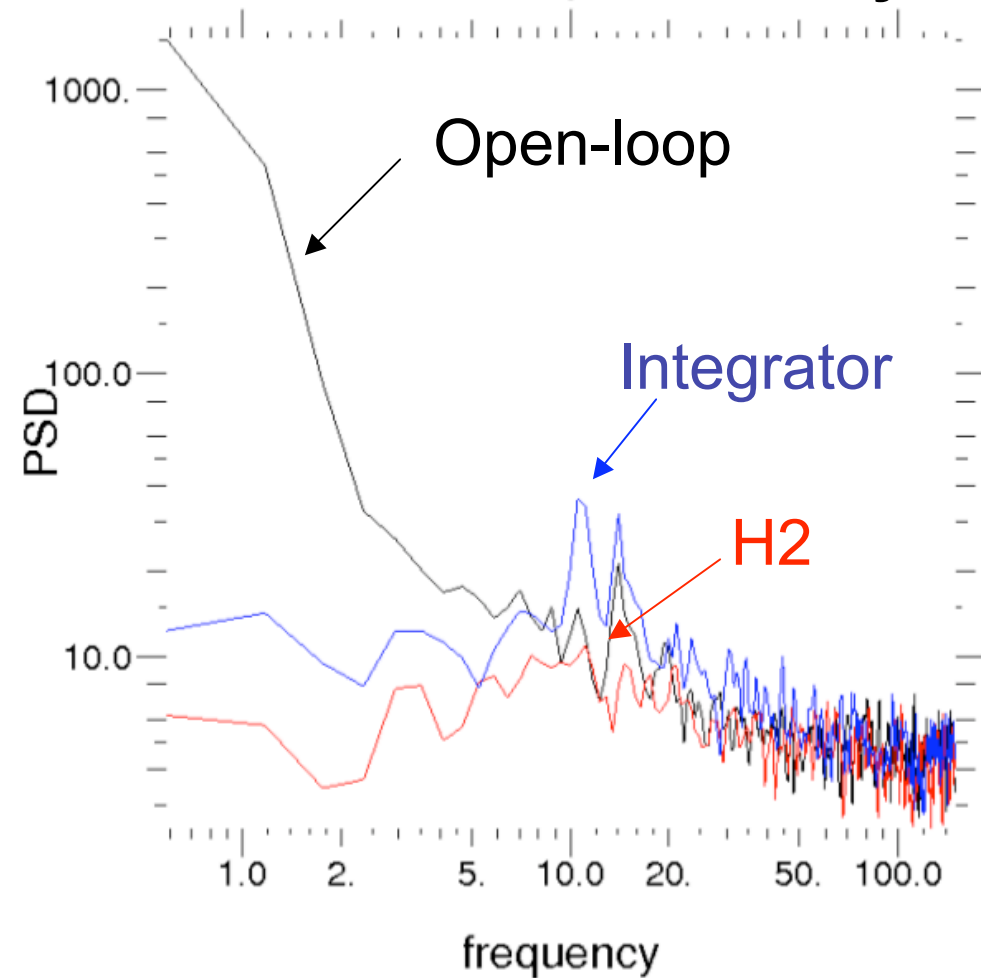
See Cortes et al. “New results on a Cn2 profiler for GeMS”
8447-217 (Poster-Thursday)

Test of advanced controllers

Fancy Rejections

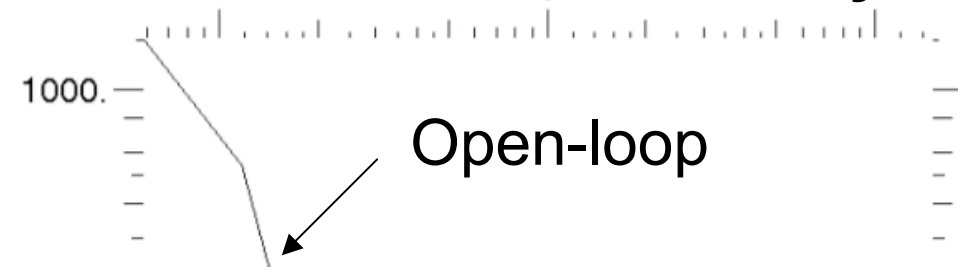


Demonstration on-sky

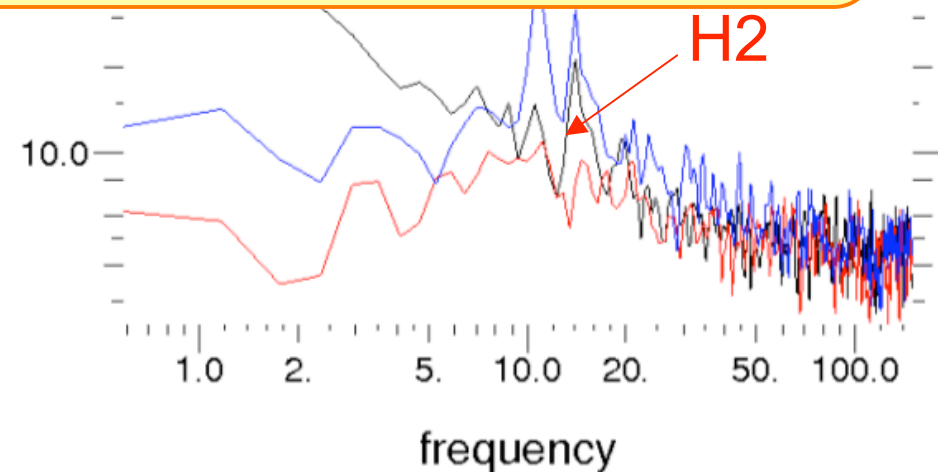
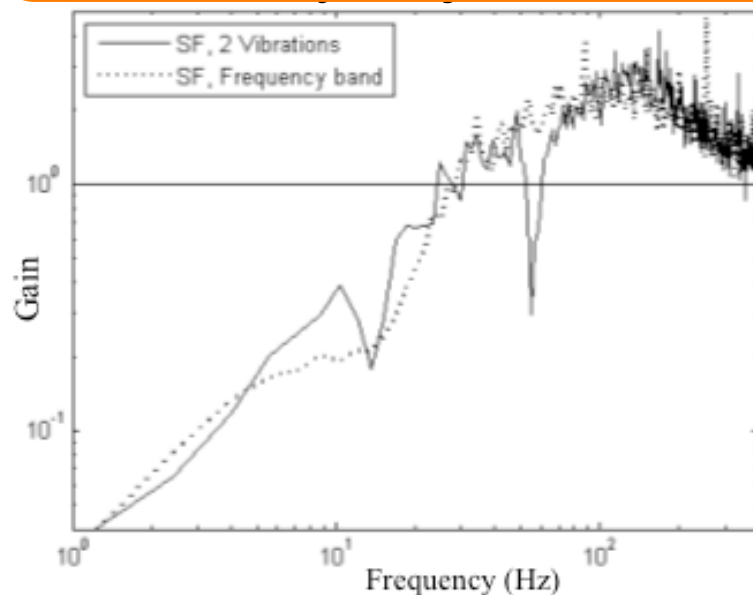


Test of advanced controllers

Demonstration on-sky

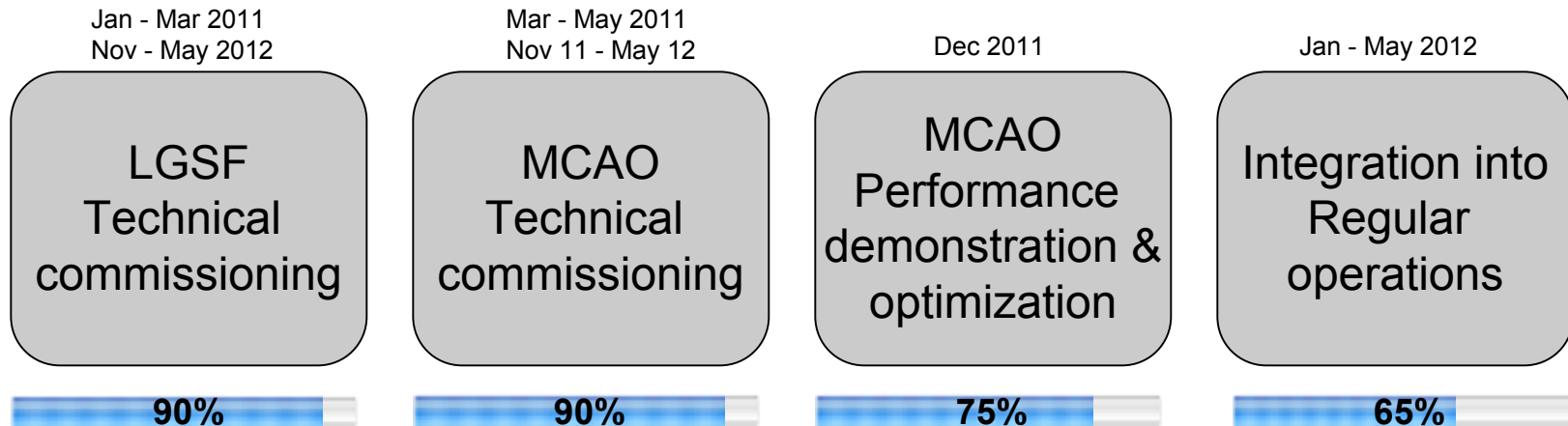


See Guesalaga et al. “Design of frequency based controllers for vibration mitigation at Gemini South”
8447-37 (This afternoon @ 14h40)



Conclusions: is GeMS ready for Science ?

What has been done:



What's missing:

Power optimization Polarization control BTO throughput ...	ADC control Science dichroïc ...	GSAOI fast ODGW NGSWFS throughput Perf. Characterization ...	Software Software Software ...
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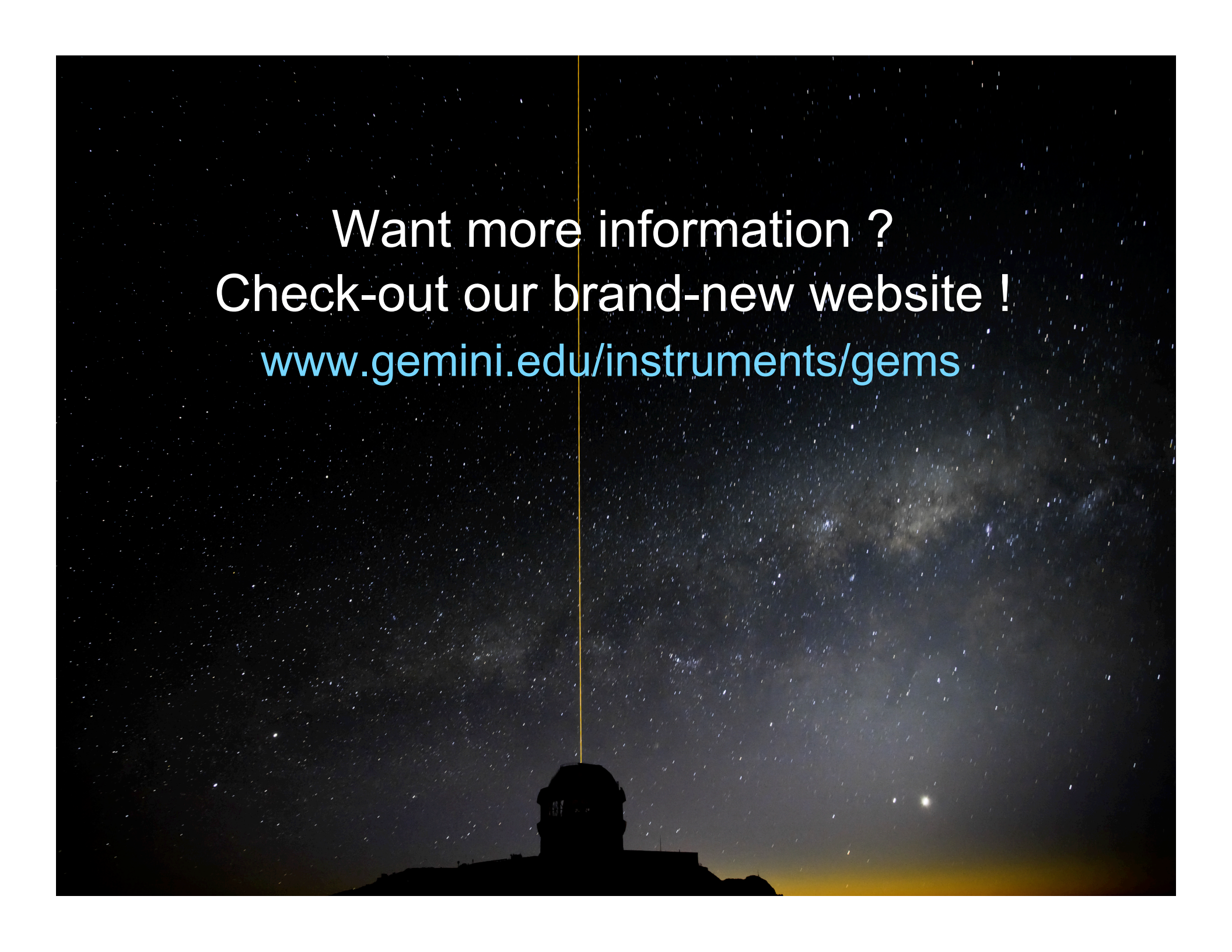
GeMS new features:

- Integrated SLODAR
- Test of advanced controllers

Commissioning is almost finished

Call for System Verification in 2012B
(open for ~80h)

Goal is to start with regular operations
in 2013A (-B)

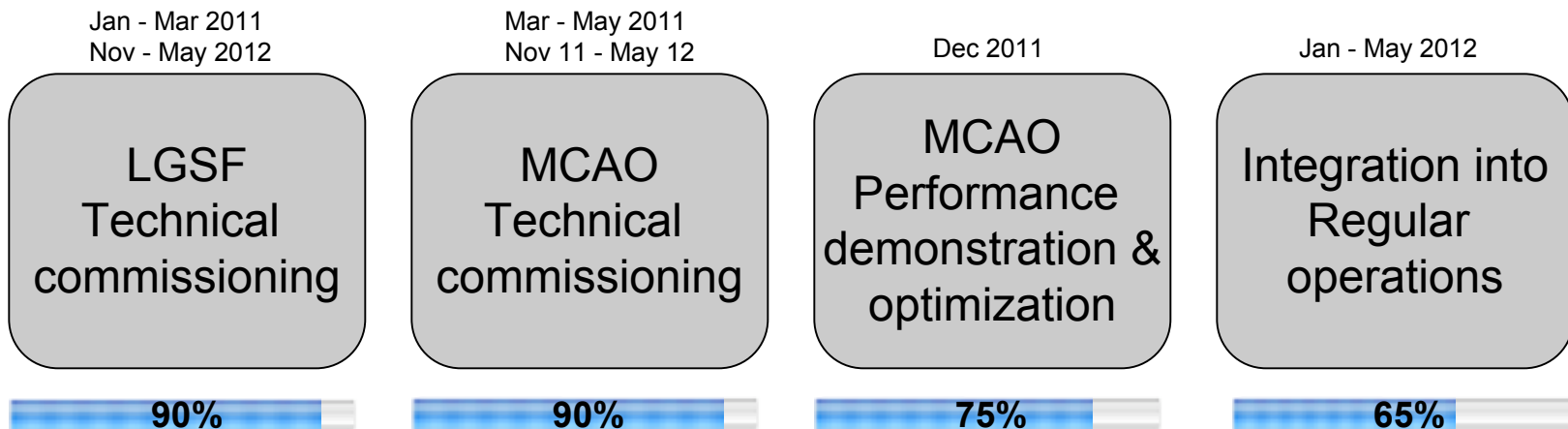


Want more information ?
Check-out our brand-new website !
www.gemini.edu/instruments/gems

Bonus

Commissioning Status

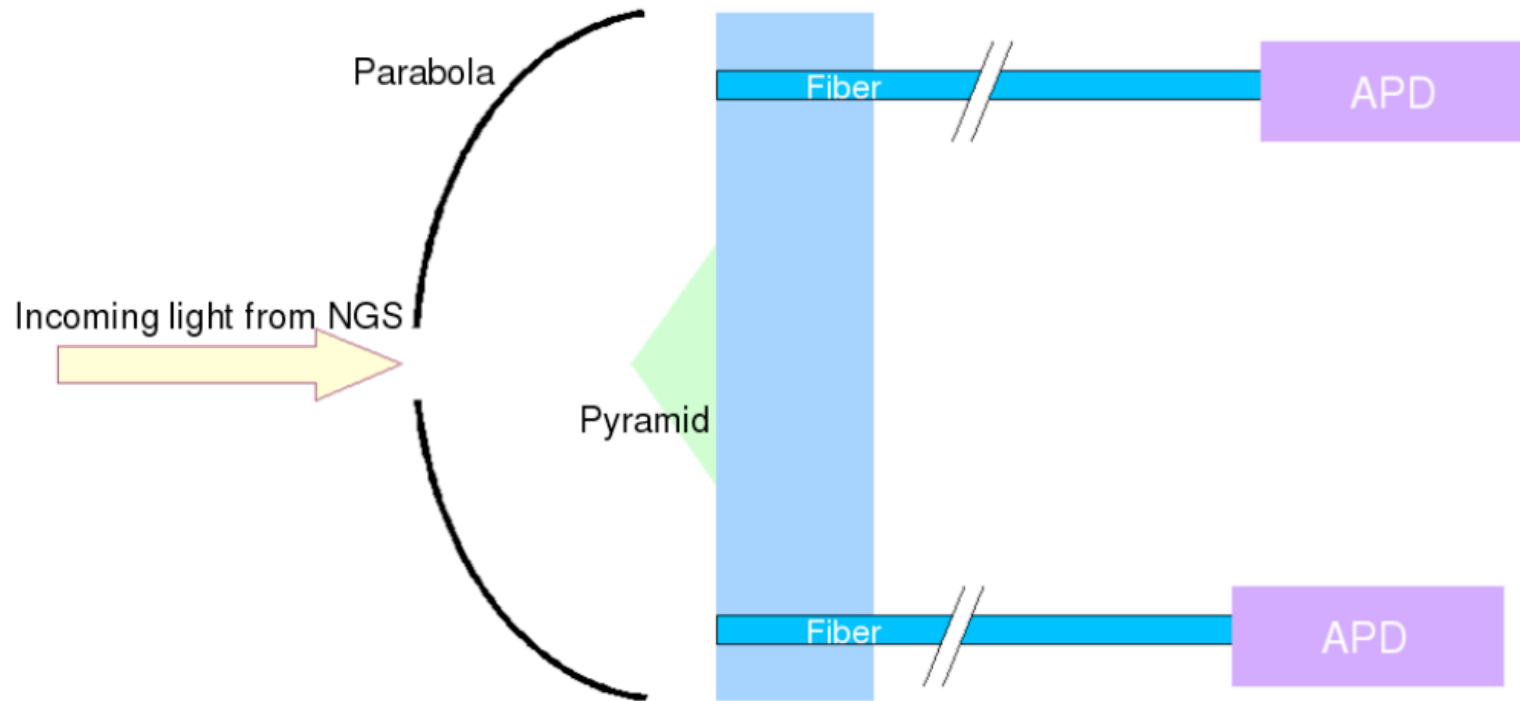
What has been done:



What's missing:

Power optimization Polarization control BTO throughput ...	ADC control Science dichroïc ...	GSAOI fast ODGW NGSWFS throughput Perf. Characterization ...	Software Software Software ...
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NGSWFS issues & Upgrades



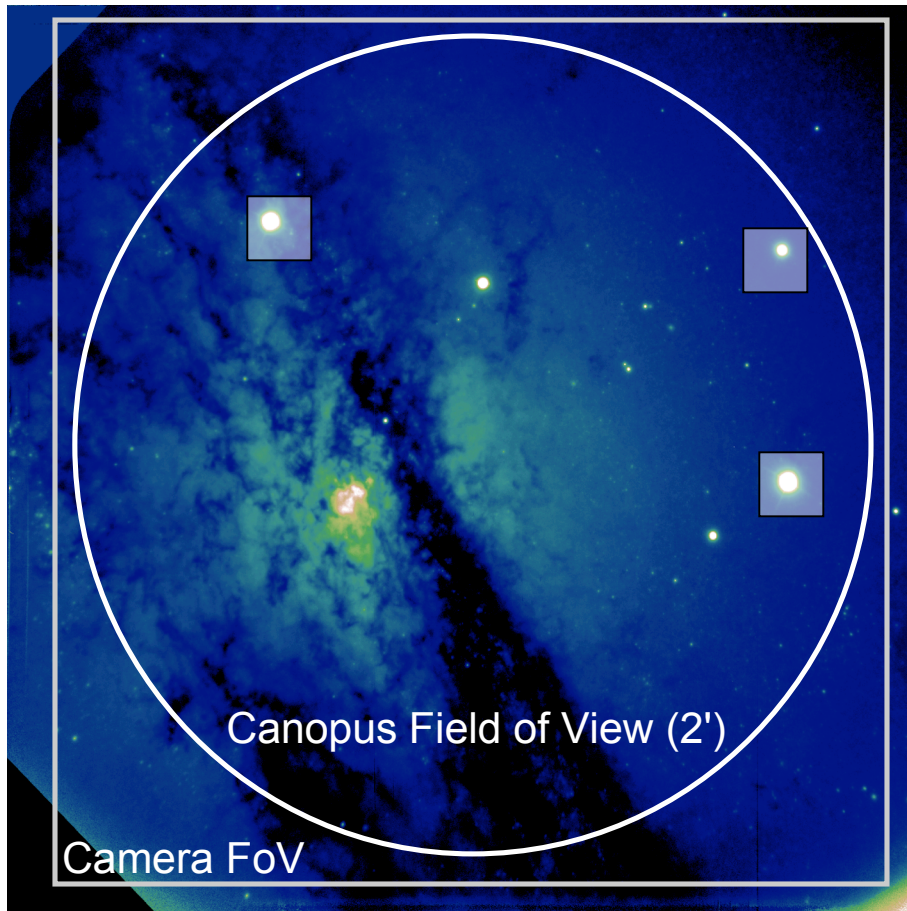
Limiting magnitude (@ 100Hz) :

Original Design	Upgrade 1.0	Goal for upgrade 2.0
R = 15.5	R = 16.5	R = 17.5

NGSWFS issues & Upgrades

- Upgrade 3.0 - “A la ODGW” -

Remove the whole NGSWFS assembly and replace it by a focal plane array that covers the 2arcmin patrol field.



Solve throughput issues
 $\Rightarrow R=18.5$

Simplified acquisition

Bonus ! Image in Visible
corrected by MCAO

Option 1 (preferred): sCMOS
Option 2: Array of 4 EMCCD

